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1. Introduction

1.1 Aim, scope and organization

The present report consists of a detailed description of the data collected and used to conduct a bibliometric analysis on the extent and characteristics of academic research in the knowledge domains of risk, sustainability and resilience. The report was prepared to support a comprehensive expert literature review and a critical analysis of the impacts on risk governance, management and education as a result of integrating sustainability and resilience considerations. Together, the report and the analysis are part of a PhD project that aims to develop a blueprint for learning design in risk-informed decision support. They provide the basis for the learning design in terms of relevant subject expertise. The research questions the study aims to answer are:

- How large is the scientific community researching resilience and sustainability in comparison to research in risk assessment, risk management and risk analysis and what is the evolutionary trajectory of these knowledge domains for the period 1990 to 2017?
- What are the characteristics of the scientific literature on risk, sustainability and resilience produced between 1990 and 2017 in terms of different disciplinary contributions, important authors, geographic distribution of research, and organizations producing research?
- To what extent are resilience and sustainability research integrated into research on risk-informed decision support and how is their influence shaping the development of the risk knowledge domain with respect to risk governance, risk management and risk education programs?

To answer the first two questions, two types of quantitative bibliometric analysis were conducted: co-occurrence network analysis of terms and bibliographic coupling network analysis of authors, countries and organizations. All specifications regarding data collection, descriptions of the data used to generate the network visualizations and the visualizations themselves are included in this report. The third question is addressed in the accompanying paper in the manner of critical qualitative discourse.

Part one provides an introduction to the problem context, the aim and scope of the report and a brief description of the methodology used for the bibliometric analysis. Part two includes evolutionary timelines for each search term, distributions of the top 10 disciplinary research areas, detailed descriptions of the data used in the visualizations of the co-occurrence network analysis of terms, and the visualizations themselves. Part three includes detailed descriptions of the data used in the visualizations of the bibliographic coupling network analysis and the visualizations themselves.

1.2 Methodology

Bibliometric methods are statistical text mining techniques that can facilitate the mapping of scientific fields through discovering patterns in the evolution, structure and composition of large volumes of scientific literature. In the present study we use two such techniques – co-occurrence network of terms and bibliographic coupling - to visualize and analyze the knowledge domains of risk, sustainability and resilience for the period 1990-2017. Based on 442171 records extracted from the Web of Science (WoS), we focus on

(i) the historical development and growth of academic research in each of the above domains,
(ii) the multidisciplinary landscape of the domains
(iii) the knowledge flows among the knowledge domains and their respective sub-disciplinary components, and
(iv) the distribution of academic expertise by author, country and organization

Because risk, sustainability and resilience research do not constitute any particular scientific field but are studied as part of multiple fields in the natural, applied and social sciences, our approach encompasses the following steps:

I. Identification of search terms relevant for risk, sustainability and resilience based on expert discussion between the authors;
II. Data collection;
III. Bibliometric networks construction;
IV. Data analysis, results and recommendations

STEP I

In step I, we identified a total of 26 search terms relevant to the knowledge domains of risk, sustainability and resilience, which we further delineated into three groups. The search terms in Group 1 are the most general and contextually broad terms, referring to typically whole knowledge domains. As research in the domain of risk has a significantly longer history and volume of scientific publications than that of either sustainability or resilience, we have split that into approximately three decades: 1990-2000, 2001-2010 and 2011-2017. Nomenclature in the risk domain is highly inconsistent in discriminating among aspects of risk research such as assessment, management or analysis. The use of these terms is strongly dependent on the sub-discipline undertaking research on risk. To be as comprehensive as possible, we designated our risk search term to encompass all three possibilities: Risk Assessment OR Risk Management OR Risk Analysis. We introduced further the three combinations Risk AND Sustainability, Risk AND Resilience and Risk AND Sustainability AND Resilience in order to facilitate analysis on the extent of mutual integration among them.

In Group 2 the search terms are chosen to represent the different multi-disciplinary perspectives in which research on resilience is undertaken. There are three such more or less distinct contexts – Ecology, Engineering and Disaster research, however in addition to the overlaps among them, here too matters of nomenclature necessitated that we subdivide the ecology domain into Ecological resilience and Spatial Resilience; the engineering domain – into Engineering Resilience, Infrastructure Resilience, and Robustness; and the Disaster domain – into Disaster Resilience, Community Resilience, Urban Resilience, and (Economic) Development Resilience.

The search terms in Group 3 are specific concepts that underpin the theoretical principles of the overarching risk, sustainability and resilience domains. The choice of search terms here was guided by the qualitative literature review and analysis performed prior to the bibliometric analysis and reflects the themes that emerged as trends in the evolution of risk research as a result of integrating sustainability and resilience considerations.

STEP II

Based on the expert-identified search terms, we extracted a total of 442,171 records from the Web of Science (WoS) database. Only journal articles and book chapters were included. As a general rule, we excluded records which were categorized as part of medical (physical and psychological) research on risk as this very large sub-domain of risk research was not deemed of relevance to the scope of our study. In section 2.3 and 3.2, where detailed descriptions of the data are given, a table of WoS categories excluded from the search is provided.

STEP III

Term Co-occurrence Network Visualizations

To provide a general overview of the significant topics related to risk, sustainability and resilience research, we constructed term maps using the VOSviewer software. VOSviewer is a text mining software based on the Apache OpenNLP toolkit, which performs part-of-speech tagging and uses a filter to identify noun phrases (terms), for which a relevance score is calculated. A low relevance score indicates that a term co-occurs with other terms following a more or less random pattern whereas a high relevance score is attributed to noun phrases that co-occur mainly with a limited set of other noun phrases (van Eck and Waltman 2017). Terms are derived from the titles and abstracts of the records downloaded from WoS. The default option is to exclude 40% of the terms based on their score. The software offers a further option to exclude terms prior to displaying the final network visualization. We have largely excluded terms with low relevance scores, which tend to be too general and non-context specific (e.g. ‘conclusion’, ‘findings’, ‘originality value’, ‘future direction’). Table 3 provides a sample of typical terms that were excluded from the visualizations. For a number of search terms, the network visualizations are composed almost entirely of low relevance score non context specific words. This has facilitated the identification of a concept’s maturity and/or ideological content (e.g. Inclusive Economy/Wealth/Growth, Social/Urban Metabolism).

A network visualization is composed of terms and links. Terms are represented by their label and a circle. The size of a label and a circle depends on the number of publications that contain the term in the title or abstract. We have chosen the binary counting option in each map, which means that the number of times a term occurs in the title and abstract is of no significance, rather a term that occurs only once is treated in the same way as one that occurs multiple times. VOSviewer offers a default choice of ten occurrences as a minimum criteria for a term to be included in a co-occurrence network. We have adapted this choice in accordance with the volume of publications we collected for each search term. For 1-1000 publications, we set the minimum criteria at 10; 1000-5000 – at 50; 5000-10000 – at 100; and above 10000 – at 200.

Links are connections or relations between two terms. Each link has a strength, which depends on the number of publications in which two terms occur together. The stronger the link, the thicker the line is in the visualization. Terms that co-occur often are located closer to each other whereas terms that have no or almost no co-occurrence are located further apart. Terms are also grouped together into clusters. A cluster represents a set of terms strongly linked together. A term may belong to one cluster only. In the visualizations a term has the same color as that of the cluster it belongs to. The clustering technique is

based on an algorithm for solving an optimization problem and is discussed in detail in Waltman, Van Eck and Noyons (2010) and Waltman and Van Eck (2013).

In most network visualizations the clusters display a rather consistent representation of the multidisciplinary structure of a field and its subfields. In addition to the visualizations, we have provided tables listing the terms in their respective clusters, the number of occurrences of each term and the total strength of the links of a term with other terms. We have introduced a color scheme in the tables to highlight (i) the significant concepts and notions related to risk, sustainability and resilience that are also discussed in their proper contexts in the qualitative analysis (blue color) and (ii) the appearance of the exact search terms identified during our expert discussion in Step I (red color).

Bibliographic Coupling Network Visualizations

In a bibliographic coupling analysis the relatedness of items is based on the number of references they share: the larger the number of shared references, the stronger the bibliographic coupling is between them. In Kessler (1963) and Van Eck and Waltman (2014), two publications are said to be bibliographically coupled if there is a third publication that is cited by both publications. In our study, we have chosen to represent the relatedness of three items: authors, countries and organizations. In each case we have chosen the fractional counting method, which purposefully diminishes the importance of highly cited publications. This allows us to be inclusive of perspectives that are not bound by what passes as significant research based on citation numbers. The difference between full counting and fractional counting in technical terms is explained in detail in Van Eck and Waltman (2014).

We have chosen to display the bibliographic coupling of authors and organizations as density visualizations and the bibliographic coupling of countries as network visualizations mainly because the density format is clearer to read in the case of large networks but also because they help to visually identify knowledge hubs and subject experts at a glance. For all density visualizations, item density rather than cluster density is displayed. As with the network visualizations, items (authors and organizations) are represented by a label, whose size is indicative of its relative importance. The colors in the density visualizations range from blue to green to red, which reflects the density of terms at each point. The 'hot' red sections of the map indicate a large number of items in the neighborhood and high weights of the neighboring items. In contrast, the 'cold' blue sections represent neighborhoods with a small number of items and low weights of neighboring items. The technical implementation of the density visualization is discussed in Van Eck and Waltman (2010).

To create the bibliographic coupling network visualizations the same search terms and WoS records were used and a similar procedure was followed as that of the term co-occurrence. After uploading the data into the VOSviewer software and selecting the fractional counting options, a minimum number of (i) publications by author, (ii) publications by country, and (iii) publications by organization were chosen. The VOSviewer default value in all cases is 5. However, we adjusted that according to the number of publications we had available for each search term, aiming to stay within the range of 50-100 items in a visualization where possible. This choice was based on trial and error experiments, which showed that visualizations were perceptually most clear at a medium size network (the maximum link display is 500).

Step IV

The data results, analysis and recommendations are not covered in the present data report; instead, the reader is referred to the accompanying study by Nielsen and Faber (2018 forthcoming) which provides the context to the concepts and perspectives and an analysis of the trends identified in the bibliometrics.

2. Co-occurrence Network Analysis of Terms

2.1 Search Terms Groups for co-occurrence network of terms analysis

Group 1 (knowledge domains)	**Group 2 (multi-disciplinary perspectives)**	**Group 3 (concepts)**
Risk 1990-2000	Ecological Resilience	Planetary Boundaries
Risk 2001-2010	Spatial Resilience	Natural Capital and Ecoservices
Risk 2011-2017	Engineering Resilience	Circular Economy
Sustainability	Infrastructure Resilience	Social OR Urban Metabolism
Resilience	Robustness	Inclusive Economy OR Inclusive Wealth OR Inclusive Growth
Risk AND Sustainability	Disaster Resilience	Degrowth
Risk AND Resilience	Community Resilience	Adaptive Governance
Risk AND Sustainability AND Resilience	Urban Resilience	Social Cohesion
	(economic) Development Resilience	Social Ecological Systems

Table 1 Search term groups for co-occurrence network of terms analysis

2.2 VOSviewer specifications for co-occurrence network of terms analysis

	Search term	**Search term**	**Search term**	**Search term**	**Search term**	**Search term**	**Search term**	**Search term**	
Group 1	**Risk 1990-2000**	**Risk 2001-2010**	**Risk 2011-2017**	**Sustainability**	**Resilience**	**Risk AND Sustainability**	**Risk AND Resilience**	**Risk AND Sustainability AND Resilience**	
Total number of records	17729	56622	143825	63390	24533	5052	3993	373	
Number of records with errors*	0	1000	4000	1000	500	0	500	0	
Title and abstract	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Binary count	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Min. number of occurrence of a term	200	200	200	200	200	100	50	10	
Threshold number of terms	349	1144	2752	1318	544	276	391	252	
60% of threshold	209	686	1651	791	326	166	235	151	
Final number of terms selected ¤	78	165	277	253	152	73	101	83	
Number of clusters	4	5	4	4* (5)	2* (3)	3	3* (4)	4	
Number of links	2982	12743	29221	28574	10967	2625	4751	2204	
Total link strength	140136	388708	662615	808450	408457	53240	47766	4215	
Group 2	**Ecological resilience**	**Spatial resilience**	**Engineering resilience**	**Infrastructure resilience**	**Robustness**	**Disaster resilience**	**Community resilience**	**Urban resilience**	**(economic) Development resilience**
Total number of records	2000	2316	989	1419	86538	2236	7070	1832	4453
Number of records with errors*	0	0	0	0	6500	0	500	500	0
Title and abstract	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Binary count	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min. number of occurrence of a term	50	50	10	50	200	50	100	50	50
Threshold number of terms	218	252	500	151	1182	250	362	135	489
60% of threshold	131	151	300	91	709	150	217	81	293
Final number	60	77	151	50	262	65	107	33	133

of terms selected									
Number of clusters	2	2	4	2* (3)	4	4	2	4	4* (5)
Number of links	1726	2857	5453	1208	29240	1957	5247	519	8129
Total link strength	30296	42728	13448	18212	892853	19759	128630	7792	83298
Group 3	**Planetary boundaries**	**Natural capital and Ecoservices**	**Circular economy**	**Social OR Urban metabolism**	**Inclusive economy OR Inclusive wealth OR Inclusive growth**	**Degrowth**	**Adaptive governance**	**Social cohesion**	**Social-ecological systems**
Total number of records	154	4115 and 32	759	1208	1287	213	1623	6015	2395
Number of records with errors‡	0	0	0	0	0	0	0	0	0
Title and abstract	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Binary count	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min. number of occurrence of a term	10	50	10	50	50	10	50	50†	50
Threshold number of terms	80	431	415	90	110	95	195	495	294
60% of threshold	48	259	249	54	66	57	117	297	176
Final number of terms selected	30	128	115	21	29	29	63	124	83
Number of clusters	3	3	3* (4)	2	3	4	4	3* (4)	4* (5)
Number of links	373	7588	3279	210	405	329	1937	6341	3323
Total link strength	1087	88609	7050	5778	6260	830	28516	54395	39378

Table 2 VOSviewer specifications for co-occurrence network of terms analysis

‡ WoS files, which showed error message when uploading in VOSviewer, and therefore not included in the visualizations.

¤ The final number of terms selected to be included in the visualization is based on the authors' subjective choice as to the relevance of each term in each particular context. As a rule, mostly terms with general, non-context specific meaning were removed. Table X presents a selected example of the type of terms which were excluded.

Research(er)	Findings	Person	Month	Literature
Implications	Survey	Conclusion	Recommendation	Concept
Limitation	Paper case study	Collaboration	Group experience	Type
Originality value	Interview	Field	Issue	Basis
Design methodology	Methodology	Application	Support	Concern
Approach	Participant	Objective	Understanding	View
Way	Author	Stakeholder	Period	Example
Framework	Individual	Year	Component	Regard
Difference	Gap	Tool	Characteristic	Organization
Discussion	Extent	Evaluation	Project	

Table 3 Example of non-context specific terms excluded from visualizations

† Here 50 instead of 100 was chosen as that yielded a more meaningful representational structure. At 100, the representation was of overly general character due to the large number of non-context specific words.

* In cases where a cluster contained only several items that could be incorporated into other clusters, the first number shows the authors' selection; the second number (in brackets) shows the original VOSviewer clustering.

2.3 Detailed Group 1 Search terms for co-occurrence network of terms analysis

Search term: Risk Assessment OR Risk Management OR Risk Analysis 1990-2017

WoS Categories excluded from search

Nursing	Pediatrics	Genetics Heredity	Parasitology	Information Science/ Library science
Otorhinolaryngology	Health Policy Services	Dentistry/ Oral Surgery Medicine	Respiratory System	Computer Science Software Engineering
Oncology	Medical Laboratory Technology	Primary Health Care	Rehabilitation	Plant Sciences
Critical Care Medicine	Urology/ Nephrology	Psychology/ Psychology Multidisciplinary	Orthopedics	Entomology
Surgery	Family Studies	Medicine Research Experimental	Tropical Medicine	Psychology Educational
Emergency Medicine	Gastroenterology/ Hepatology	Anesthesiology	Health Care Sciences Services	Evolutionary Biology
Cardiac Cardiovascular Systems	Rheumatology	Anesthesiology	Social Work	Psychology Applied
Medicine General Internal	Physiology	Neurosciences	Dermatology	Hospitality/ Leisure/ Sport/ Tourism
Engineering Biomedical	Pharmacology Pharmacy	Allergy	Geriatrics/ Gerontology	Integrative Complementary medicine
Substance Abuse	Sport Sciences	Radiology Nuclear Medicine Medical Imaging	Biochemistry Molecular Biology	Spectroscopy
Clinical Neurology	Infectious Diseases	Pathology	Education Educational Research	Chemistry Medicinal
Virology	Dentistry Oral Surgery Medicine	Hematology	Psychology Clinical	Medicine Legal
Psychiatry	Medical Informatics	Cell Biology	Social Sciences Biomedical	Developmental Biology
Ophthalmology	Immunology	Nutrition Dietetics	Transplantation	Ornithology
Endocrinology Metabolism	Mathematical Computational Biology	Psychology Developmental	Zoology	Andrology
Reproductive Biology	Obstetrics Gynecology	Peripheral Vascular Disease		

Table 4 WoS Categories excluded from search term Risk Assessment OR Risk Management OR Risk Analysis

Evolution Timeline

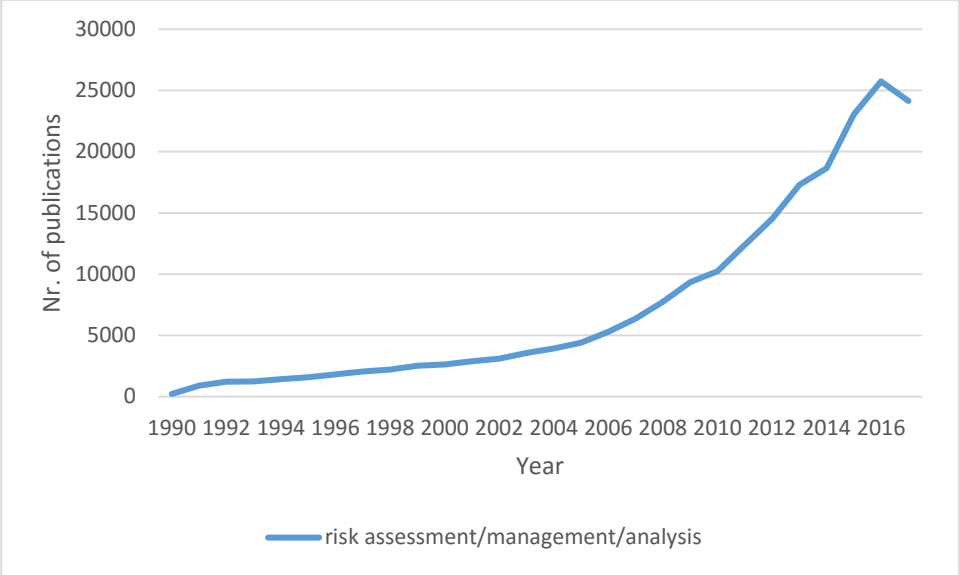

Fig. 1 Evolution of research on risk 1990-2017

Top 10 Research Areas

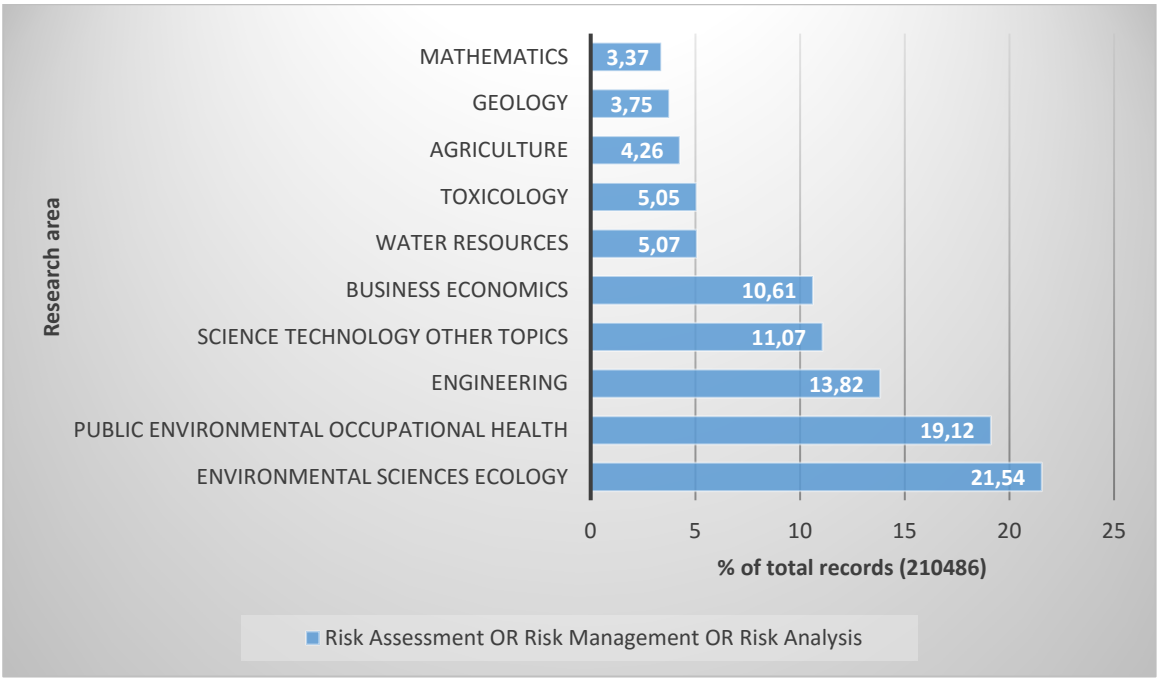

Fig. 2 Top 10 Research Areas in the context of risk

Network visualization for Risk Assessment OR Risk Management OR Risk Analysis 1990-2000

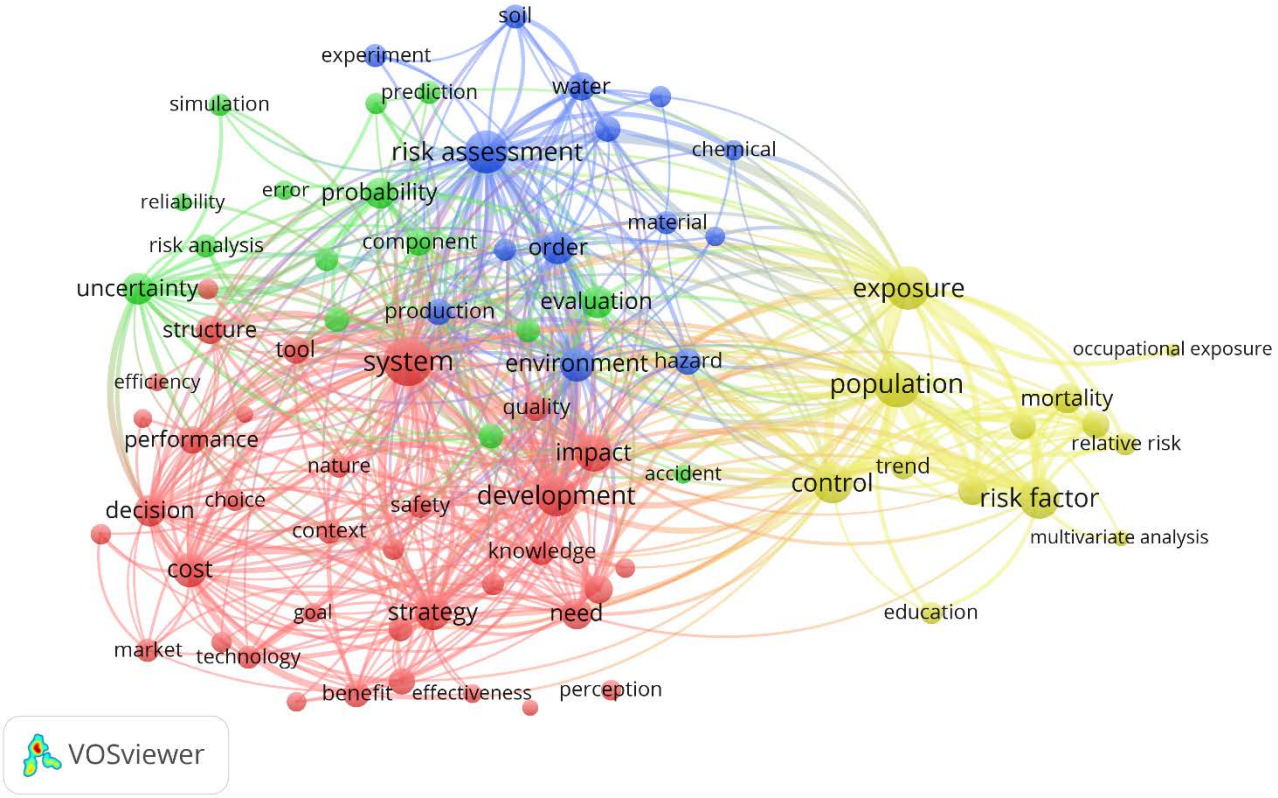

Fig 3 Risk research 1990-2000

A Cluster and term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Action	566	2760	Accident	421	1991	Chemical	496	2471	Control	1829	7205
Alternative	410	2045	Assumption	604	2597	Contamination	514	2178	Death	852	3056
Benefit	784	3810	Component	825	3613	Environment	1321	6317	Education	559	1843
Choice	517	2249	Consequence	694	3430	Experiment	595	2272	Exposure	2107	7679
Context	670	3115	Criterium	664	3094	Growth	561	2512	History	979	3569
Cost	1300	6229	Error	459	1867	Hazard	778	3429	Incidence	738	2452
Decision	1127	5323	Evaluation	1224	5428	Health risk	457	1964	Mortality	1023	3715
Development	1891	8627	Failure	687	3119	Material	613	2699	Multivariate analysis	317	983

Effectiveness	408	1906	Prediction	590	2516	Order	1230	5439	Occupational exposure	230	955
Efficiency	387	1763	Probability	1060	4545	Production	822	3972	Population	2412	8743
Goal	457	2339	Reliability	360	1696	Risk assessment	2049	7977	Relative risk	613	1981
Impact	1501	7064	Risk analysis	623	2738	Soil	642	2764	Risk factor	1926	5538
Industry	912	4421	Simulation	570	2637	Species	750	2909	Trend	677	2597
Knowledge	796	3747	Uncertainty	1141	5395	Water	904	4026			
Market	602	2518	Variability	532	2422						
Nature	578	2723									
Need	1088	5145									
Opportunity	453	2243									
Perception	468	1797									
Performance	853	4025									
Policy	778	3713									
Protection	433	2190									
Quality	754	3697									
Regulation	515	2578									
Resource	665	3507									
Return	503	1886									
Risk management	497	1911									
Safety	654	3446									
Solution	484	2224									
Strategy	1394	6457									
Structure	920	4093									
System	2627	11937									
Technology	611	3328									
Tool	875	4230									
Utility	339	1429									
World	294	1464									

Table 5 Cluster and term specification Risk 1990-2000

Network visualization for Risk Assessment OR Risk Management OR Risk Analysis 2001-2010

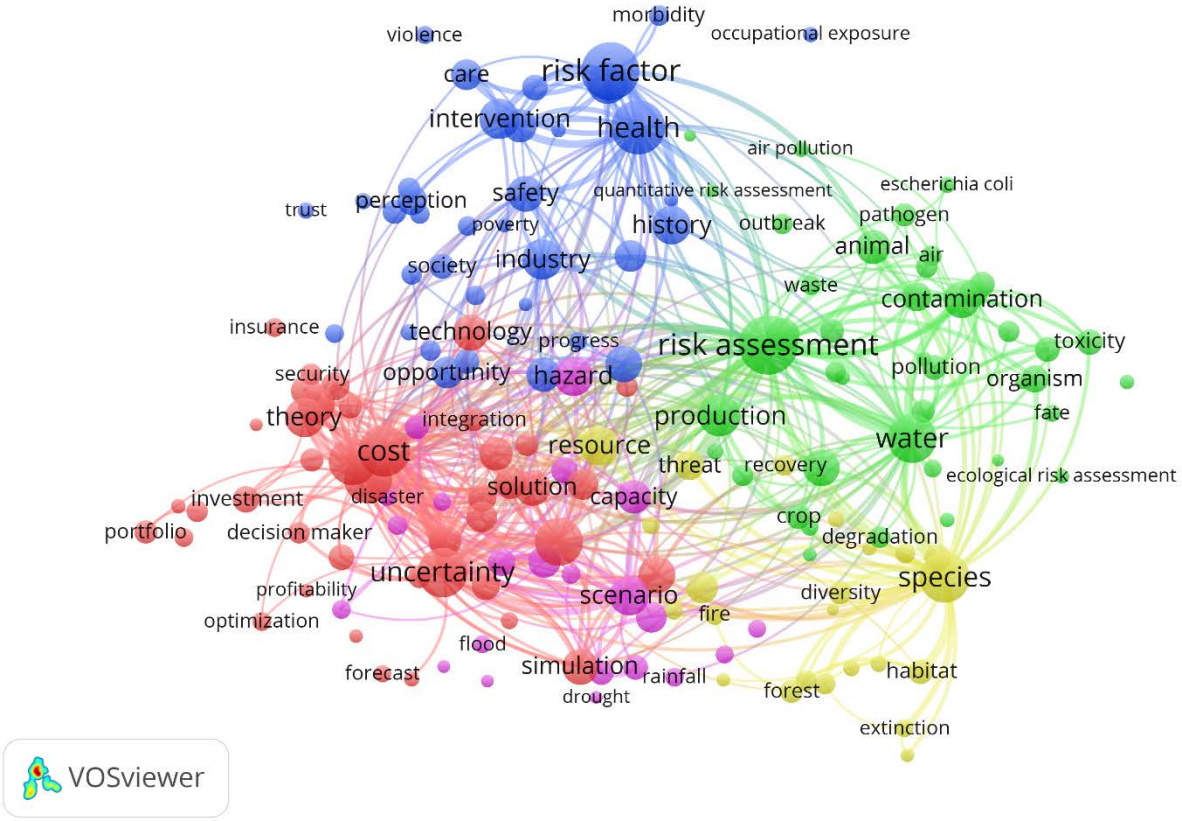

Fig. 4 Risk research 2001-2010

Cluster and term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5		
Term	**Occ**	**Link st**	**Term**	**Occ**	**Link st**	**Term**	**Occ**	**Link st**	**Term**	**Occ**	**Link st**	**Term**	**Occ**	**Link st**
Alternative	1263	5630	Agriculture	721	4097	Action	2074	9731	Biodiversity	441	2867	Adaptation	577	2977
Asset	735	2850	Air	671	2680	Care	1520	4132	Conservation	742	4252	Building	926	4337
Assumption	1573	6214	Air pollution	377	1151	Communication	898	3835	Diversity	855	3986	Capacity	1712	7791
Capability	789	3406	Animal	1832	6050	Conflict	631	2844	Dynamic	1567	6738	Climate	954	5202
Choice	1485	5695	Bioavailability	333	1302	Construction	968	4189	Ecology	359	1880	Climate change	962	6045
Complexity	848	3851	Chemical	1267	5770	Crisis	557	2218	Ecosystem	1086	6280	Damage	1626	6861
Cost	4021	16432	Contaminant	961	4371	Danger	309	1267	Extinction	529	2856	Disaster	506	2627
Decision	3558	15997	Contamination	2074	8505	Expert	677	3184	Extinction risk	314	1738	Drought	264	1567
Decision maker	723	3997	Crop	998	4912	Health	4522	14094	Fire	651	2943	Earthquake	541	2370

Decision making	1275	6525	Degradation	709	3424	History	2267	6271	Fishery	308	1486	Erosion	508	2453
Economy	861	3736	Ecological risk assessment	289	1301	Industry	2490	10261	Forest	847	4166	Flood	527	2769
Efficiency	1502	6276	Emission	909	4348	Injury	1041	2936	Habitat	936	4906	Flood risk	265	1322
Empirical evidence	269	947	Environmental impact	378	2120	Intervention	2469	7208	Human activity	236	1340	Flow	1446	6270
Energy	747	3373	Environmental risk	642	3122	Lesson	428	2052	Landscape	644	3485	Future	1119	5480
Error	1272	4277	Environmental risk assessment	289	1301	Morbidity	686	1711	Persistence	591	2686	Hazard	2353	10190
Forecast	485	1989	Escherichia coli	427	1577	Nature	1779	7367	Productivity	566	2828	Infrastructure	638	3491
Insurance	574	1976	Experiment	2070	7391	Occupational exposure	400	923	Recovery	748	3033	Land use	514	2912
Integration	849	3876	Fate	489	2549	Opportunity	1521	6719	Resource	2367	11831	Landslide	281	1267
Investment	1107	4966	Food safety	230	1060	Participation	752	2796	Species	3922	16498	Mitigation	520	2959
Monte carlo simulation	476	2102	Human	1295	5213	Perception	1415	5518	Sustainability	490	2945	Rainfall	561	2702
Network	1707	6911	Human health	734	3612	Poverty	326	1078	Synthesis	403	1776	Scenario	2407	12000
Optimization	547	2298	Irrigation	289	1658	Prevention	1770	5760	Threat	1363	6822	Vulnerability	1209	5956
Option	1628	7770	Limit	1726	6222	Progress	495	2231	Vegetation	425	2197			
Performance	3529	12123	Mobility	354	1401	Public	639	3083						
Portfolio	818	2670	Nutrient	355	1611	Regression analysis	2583	5122						
Prediction	2133	8435	Organism	1140	5226	Regulation	1550	6244						
Preference	824	3283	Outbreak	668	2333	Responsibility	627	2770						
Probability distribution	386	1762	Pathogen	850	3303	Risk factor	5234	10277						
Profitability	304	1405	Pesticide	734	3112	Risk perception	430	1835						
Reliability	1004	3691	Pollutant	968	4291	Rural area	288	884						
Risk analysis	1517	6121	Pollution	987	4779	Safety	1977	7959						
Risk aversion	329	1152	Production	2672	11699	Society	971	4356						
Risk management	2150	8572	Quantitative risk	254	1077	Stakeholder	675	4003						

			assessment											
Robustness	304	1296	Risk assessment	5441	20770	Survival analysis	329	642						
Security	748	3192	Spatial distribution	458	1799	Trust	417	1705						
Simulation	2005	8455	Toxicity	1040	4305	Violence	526	1278						
Solution	2048	8533	Transformation	435	1735									
Structure	3566	13808	Transport	858	3921									
Technology	2000	8754	Waste	624	3045									
Theory	2374	8337	Water	3635	15798									
Uncertainty	3745	17134	Water quality	498	2668									
Volatility	559	1741	Wildlife	237	1331									

Table 6 Cluster and term specification Risk 2001-2010

Network visualization for Risk Assessment OR Risk Management OR Risk Analysis 2011-2017

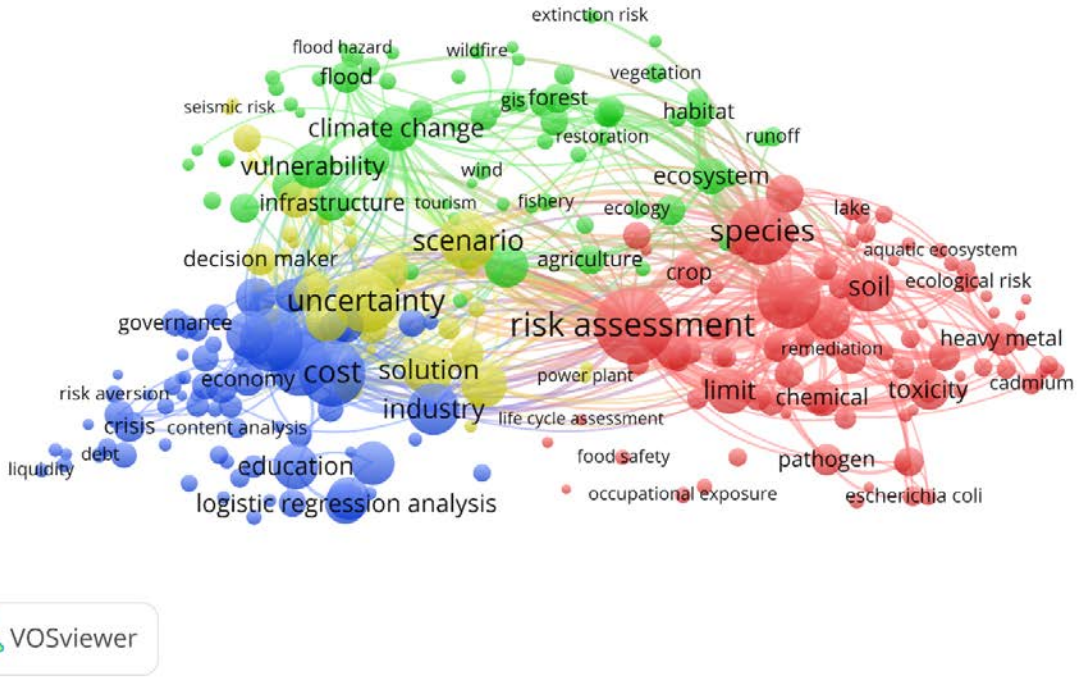

Fig. 5 Risk research 2011-2017

Cluster and term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Adsorption	379	1399	Adaptation	1929	9056	Accountability	272	916	Algorithm	3411	8837
Air	1345	4739	Adaptive capacity	312	1949	Actor	1126	4200	Architecture	716	2002
Algae	300	1371	Agriculture	1748	9309	Business	1458	5014	Bayesian network	355	1152
Anthropogenic activity	390	2330	Biodiversity	1058	5677	Commodity	401	1289	Building	2589	9328
Anthropogenic source	283	1605	Catchment	914	4960	Complexity	2477	8960	Capability	2097	7026
Aquatic ecosystem	503	2694	Climate change	4155	21637	Conflict	1575	5260	Collapse	612	2067
Atmosphere	575	2329	Climate change adaptation	297	1874	Construction industry	312	885	Complex system	269	1147
Bacterium	1734	5465	Climate risk	235	1375	Content analysis	835	1673	Cost benefit analysis	377	1639
Bioaccumulation	517	2544	Coastal area	542	2830	Cost	8753	27763	Decision maker	2048	9447
Bioavailability	744	3388	Degradation	1801	7564	Credibility	278	888	Decision support system	381	1687
Biomass	977	4305	Disaster risk reduction	312	1531	Credit risk	393	775	Earthquake	1534	5490
Biota	491	2624	Drought	1099	5699	Crime	578	916	Efficiency	4316	14543
Cadmium	932	4877	Earth	367	1571	Crisis	2040	5636	Electricity	363	1668
Chemical	2622	9412	Ecology	746	3021	Debt	509	1412	Energy	2122	7794
Chromium	478	3013	Ecosystem	2702	14315	Decision	8054	26921	Engineer	544	2029
Cluster analysis	883	2874	Ecosystem service	519	3292	Decision making	3155	12156	Engineering	948	3316
CO2	598	2312	Erosion	842	4137	Disorder	3656	3304	Explosion	369	1252
Coal	500	2497	Extinction risk	430	1541	Diversification	644	2308	Failure mode	472	1306
Combustion	670	2937	Extreme event	427	2178	Economic development	502	2510	Finite element analysis	286	379
Contaminant	1998	8843	Fire	1420	5623	Economic growth	344	1553	Fuzzy logic	214	789
Copper	716	4139	Fire risk	322	1476	Economy	2143	8279	Monte Carlo simulation	992	3534
Correlation analysis	771	2246	Fishery	584	2493	Education	4149	6986	Net present value	251	1128
Crop	2023	9267	Flood	1967	9808	Equity	693	1880	Nuclear power plant	361	1066

Drinking water	975	3936	Flood hazard	247	1311	Ethnicity	1509	1263	Optimization	1652	5695
Dust	830	3043	Flood risk	1013	5292	Expert	1758	6104	Power plant	388	1880
E coli	604	2550	Flood risk management	476	2461	Expertise	594	2210	Probabilistic approach	261	1020
Ecological risk	1111	5814	Food security	450	2490	Fear	691	1489	Probability distribution	680	2649
Ecological risk assessment	769	3774	Forest	1859	8503	Flexibility	1067	3709	Quantitative risk assessment	323	1007
Emission	2591	11661	GIS	964	4537	Global financial crisis	329	892	Reliability	2513	7445
Enrichment	693	2673	Global scale	220	1122	Governance	1471	5814	Reliability analysis	347	1086
Environmental impact	997	5168	Habitat	1837	7997	Immigrant	354	487	Risk analysis	2725	9095
Environmental risk	1512	6878	Human activity	746	4082	Industry	5351	17639	Risk evaluation	571	2064
Environmental risk assessment	728	2967	Hurricane	227	1076	Inequality	1066	2090	Risk mitigation	413	1784
Escherichia coli	863	3288	Infrastructure	2351	10362	Information technology	293	1011	Robustness	939	3198
Estuary	539	2696	Integrated approach	368	1723	Innovation	1154	3813	Safety risk	371	1065
Exposure assessment	717	1974	Land use	1254	7064	Integration	2196	8111	Scenario	6597	27146
Extraction	1695	5851	Landscape	1579	7291	Leadership	370	1180	Seismic hazard	305	1057
Fate	1037	4794	Landslide	754	3059	Learning	929	2728	Seismic risk	370	1311
Fertilizer	543	2904	Livelihood	497	2752	Life expectancy	280	499	Simulation model	568	2258
Food chain	397	1751	Local scale	238	1266	Liquidity	408	888	Solution	5153	17871
Food safety	467	1615	Mitigation	1462	7147	Logistic regression analysis	3490	2668	Tradeoff	464	2296
Freshwater	270	1442	Natural disaster	597	2801	Nutrition	633	1085	Tsunami	294	1238
Geoaccumulation index	225	1367	Natural hazard	567	3015	Ownership	602	1675	Uncertainty	8065	30327
Groundwater	1218	6173	Natural resource	387	2278	Poisson regression	337	352			
Heavy metal	2101	10896	Pest	479	1993	Policy	7381	25095			
Heavy metal pollution	252	1639	Population growth	350	1843	Portfolio	1728	4567			
Human consumption	271	1243	Precipitation	1351	6023	Privacy	341	813			
Human health risk	713	3284	Preparedness	641	2848	Regression analysis	3889	4620			
Industrial activity	251	1464	Rainfall	1396	6289	Responsibility	1451	4875			
Insecticide	489	1606	Regional scale	385	1945	Risk attitude	250	822			
Irrigation	746	4345	Remote sensing	354	1820	Risk aversion	678	1852			

ISO	267	787	Resilience	1738	8335	Risk communication	401	1446			
Lake	1021	5077	Restoration	557	2766	Risk management	4471	14417			
Landfill	289	1439	Risk map	450	2080	Risk perception	1049	3227			
Life cycle assessment	269	1554	Runoff	750	4341	Satisfaction	745	1418			
Limit	4299	13776	Satellite	282	984	Security	2047	7286			
Mercury	695	3195	Scarcity	466	2466	Self-efficacy	436	621			
Microorganism	653	2417	Sea level rise	382	2360	Social capital	252	729			
Mine	665	2900	Soil erosion	352	1995	Social network	396	899			
Mining	967	4146	Storm	576	2661	Society	2445	8789			
Mobility	917	3442	Sustainable development	551	2929	Stakeholder	2342	10459			
Nanomaterial	486	1620	Synergy	266	1273	Stock market	506	1020			
Nanotechnology	208	750	Threat	3831	15704	Suicide	475	507			
Nickel	408	2636	Tourism	284	1255	Supply chain	1167	4133			
Nitrogen	844	4087	Urbanization	670	3278	Sustainability	1501	7201			
Occupational exposure	540	1043	Vegetation	821	4085	Systemic risk	267	726			
Pathogen	2050	5716	Vulnerability	3965	16869	Trade	1378	4819			
Persistent organic pollutant	266	981	Vulnerability assessment	487	2542	Transparency	506	1848			
Pesticide	1782	6861	Watershed	642	3682	Trust	1080	3130			
Phosphorus	631	3109	Wetland	542	3065	Unemployment	362	710			
Pollution	3765	16547	Wildfire	482	2389	Volatility	1334	3092			
Quantitative microbial risk assessment	225	1026	Wildlife	559	2232						
Remediation	513	2479	Wind	680	2709						
Risk assessment	12094	39529									
River	2926	14670									
Salinity	379	1837									
Salmonella	477	1475									
Soil	5256	23864									
Species	8617	27644									
Station	1558	5834									
Toxicity	3351	11067									
Traffic	893	2869									

Transport	1779	7194									
Waste	1429	6502									
Wastewater	947	4719									
Water quality	1186	6527									
Wheat	494	2084									
Wood	305	1267									
Zinc	536	3214									

Table 7 Cluster and term specification Risk 2011-2017

Search term: Sustainability 1990-2017

WoS categories excluded from search

Social work	Medicine General Internal	Genetics Heredity	Psychiatry	Nursing	Pediatrics

Table 8 WoS categories excluded from search term Sustainability

Evolution timeline

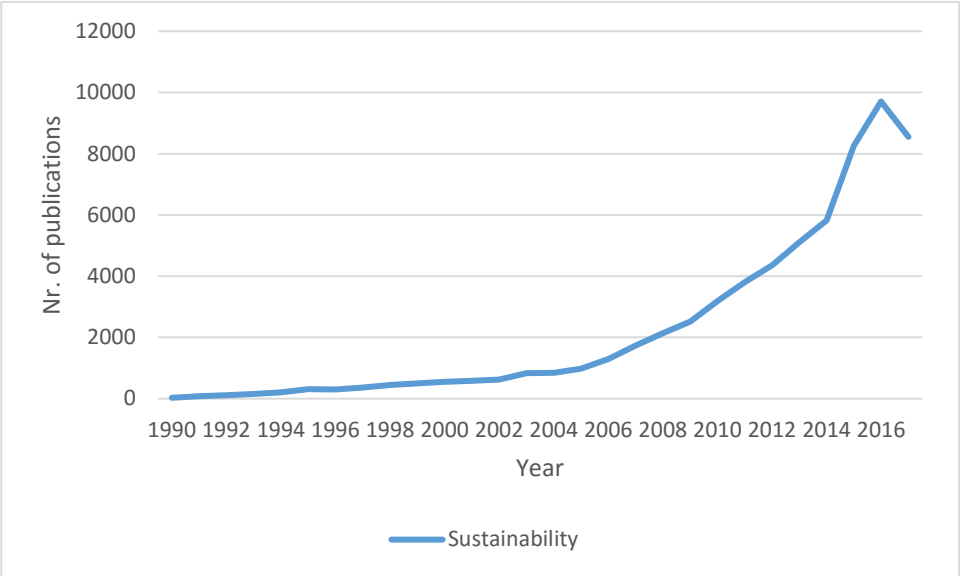

Fig. 6 Evolution of research on sustainability 1990-2017

Top 10 Research Areas

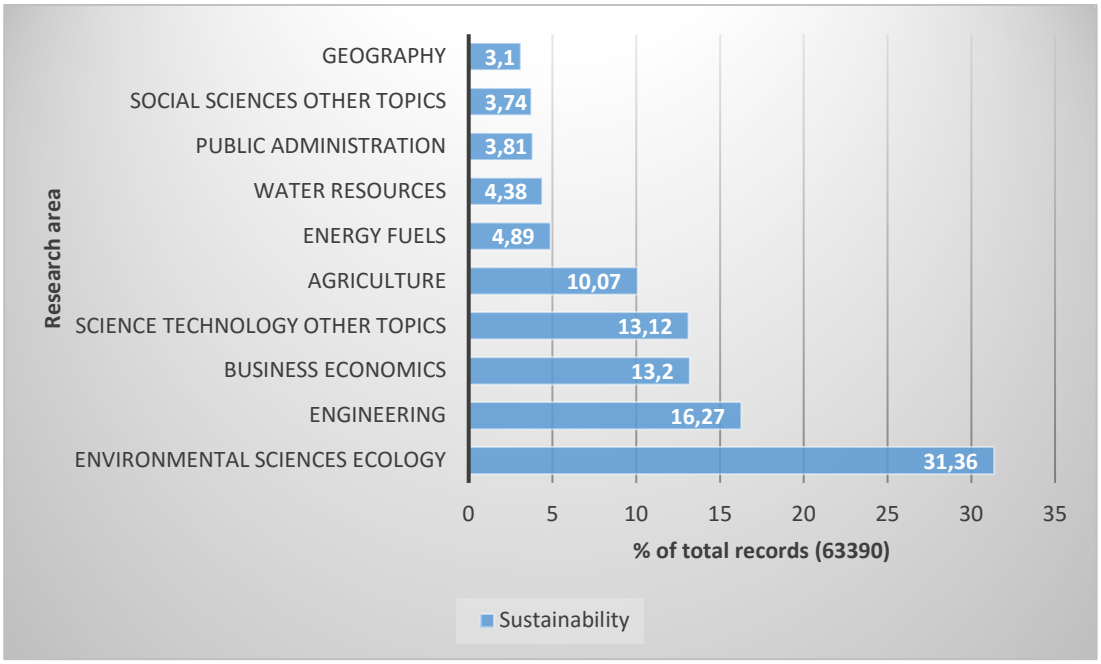

Fig. 7 Top 10 Research Areas in the context of sustainability

Network visualization

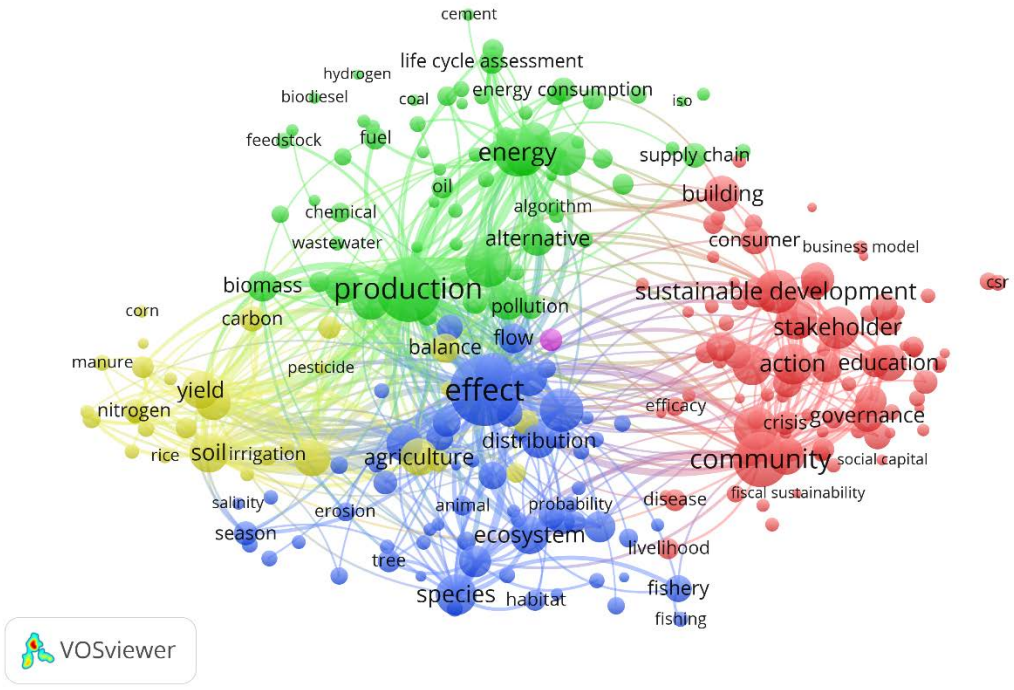

Fig. 8 Network visualization of sustainability

Cluster and term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Acceptance	624	2958	Air	476	2899	Animal	835	5266	Agricultural sustainability	440	3124
Accountability	412	1811	Algorithm	681	2763	Aquaculture	413	2603	Agricultural system	539	4049
Action	3571	16582	Alternative	2517	13783	Biodiversity	1497	10365	Agriculture	2990	19837
Actor	1809	8084	Atmosphere	313	2165	China	2604	14216	Balance	1828	11447
Architecture	693	2806	Biodiesel	301	2319	Climate	1630	10526	Carbon	1419	10549
Art	466	1809	Bioenergy	309	2724	Damage	782	4661	Corn	329	2713
Awareness	1670	7833	Biofuel	680	5269	Deforestation	367	2794	Crop	2604	20468
Building	2689	11851	Biomass	2039	15376	Degradation	1672	10940	Crop yield	456	4133
Business model	411	1539	Carbon footprint	419	2608	Distribution	2473	13087	Farming	1097	7088
Capacity building	262	1251	Cement	341	1600	Disturbance	543	3701	Fertilization	439	3794
Care	1555	5592	Chemical	872	5699	Diversity	2069	12118	Fertilizer	1025	9137
Civil society	228	1101	CO2 emission	517	3097	Drought	485	3316	Food production	581	4382
Collaboration	1351	6002	Coal	318	2207	Ecosystem	3120	19723	Food security	839	5837
Communication	1275	5512	Construction industry	362	1713	Ecosystem service	1062	7082	Grain	396	3109
Community	6544	30465	Conversion	891	6287	Effect	10665	55944	India	1302	7548
Complex system	221	1088	Degrees C	680	3291	Erosion	758	5642	Irrigation	922	6660
Complexity	1663	7871	Depletion	925	6414	Fire	262	1710	Maize	499	4359
Conflict	1411	7059	Efficiency	4698	25666	Fishery	1565	7307	Manure	556	4949
Consumer	1740	7680	Electricity	817	5269	Fishing	539	2885	Nitrogen	1166	9803
Content analysis	473	1759	Energy	4954	28732	Flow	1919	10616	Nutrient	980	8152
Continuity	293	1304	Energy consumption	1247	7083	Forest	2223	14187	Pesticide	358	2646
Corporate social responsibility	678	2684	Energy efficiency	862	4739	Forest management	506	2976	Phosphorus	601	5080
Cost effectiveness	312	1459	Energy production	341	2437	GIS	379	1983	Production system	1132	8384
Credibility	241	999	Environmental assessment	362	2055	Grassland	429	3444	Productivity	2818	19909
Crisis	1229	5377	Environmental impact	2979	18323	Groundwater	689	3976	Rice	531	4349

CSR	540	2159	Environmental indicator	251	1464	Growth	4092	22485	Soil	3290	24859
Culture	1723	7936	Environmental performance	988	5621	Growth rate	534	3031	Soybean	260	2333
Decision making	1882	8926	Ethanol	331	2506	Habitat	943	5946	Wheat	704	6100
Designer	442	1935	Extraction	803	4906	Human activity	525	3200	Yield	2935	21220
Disease	1018	4693	Feedstock	557	4664	Index	2916	15315			
Ecological footprint	376	1871	Fossil fuel	583	4507	Land use	1559	10561			
Economic growth	1005	4955	Fuel	1104	7827	Land use change	505	3941			
Education	2891	11020	GHG emission	374	3055	Livestock	458	3472			
Efficacy	811	3431	Global warming	471	3423	Long term	1095	6186			
Emergence	799	3730	Greenhouse gas	446	3518	Long term sustainability	1460	7507			
Empowerment	325	1592	Hydrogen	225	1294	Loss	2860	18497			
Engineer	479	2384	ISO	263	1351	Migration	388	1895			
Engineering	839	3921	LCA	985	7373	Mortality	656	3351			
Environmental education	243	1005	Life cycle assessment	1345	9627	Pasture	571	4109			
Equity	931	4559	Manufacturing	662	3260	Persistence	328	1811			
Ethic	481	2062	Material	4015	20239	Population growth	573	3477			
Evidence	4118	16979	Mitigation	624	3969	Precipitation	482	3312			
Expert	1033	4861	Oil	1048	6333	Probability	543	2500			
Financial sustainability	472	1528	Optimization	902	4575	Rainfall	548	4004			
Fiscal sustainability	216	518	Plant	2777	17614	Regional scale	243	1513			
GDP	402	1897	Pollutant	368	2269	Restoration	554	3613			
Geography	370	1358	Pollution	1336	8518	River	798	4545			
Globalization	346	1639	Production	8803	55493	Salinity	341	2448			
Governance	2234	10107	Property	2917	14995	Season	1255	8817			
Holistic approach	263	1368	Raw material	570	3778	Short term	371	2132			
Humanity	306	1543	Recovery	1288	7222	Simulation	1487	8043			
Identity	681	2832	Recycling	838	5110	Species	3550	20557			
Inequality	485	2307	Renewable energy source	320	2025	Stability	1370	7064			
Innovation	2403	9980	Reuse	557	3102	Survival	784	4078			

Intervention	2844	11714	Scenario	3354	19475	Threshold	592	3277			
Justice	588	2527	Substitution	332	1978	Tree	1080	7161			
Leadership	886	3838	Supply chain	1335	6062	Urbanization	624	3567			
Learning	1285	5316	Sustainability assessment	980	4943	Variability	1223	7725			
Legitimacy	377	1622	Sustainability criterium	450	2371	Vegetation	694	5173			
Lifestyle	401	1901	Sustainability index	606	2937	Water quality	622	4136			
Livelihood	944	5843	Sustainability performance	464	1970	Watershed	391	2548			
Local government	458	1961	Transportation	821	4304	Wetland	370	2382			
Natural capital	249	1371	Waste	2063	11997	Wildlife	227	1378			
Natural environment	416	2105	Waste management	427	2423						
Nature	3277	14851	Wastewater	466	2958						
Ownership	634	2873	Wind	265	1624						
Participation	2089	9543	Wood	433	3065						
Perception	2117	9209									
Planet	441	2393									
Poverty	671	3660									
Public health	389	1797				* Resistance	1093	4945			
Public policy	401	1715									
Reform	1031	4254									
Responsibility	1544	6641									
Rural community	377	1975									
Satisfaction	626	2364									
Social capital	283	1403									
Social ecological system	410	2194									
Social science	259	1195									
Social sustainability	548	2295									
Society	3507	16537									
Stakeholder	3753	16953									
Sub Saharan Africa	302	1631									
Sustainability goal	349	1602									
Sustainability science	296	1321									
Sustainable consumption	217	904									
Sustainable development	4106	17602									

Tourism	1161	4544									
Transition	1853	8883									
Transparency	471	2310									
Triple bottom line	208	806									
Trust	553	2646									
Urban sustainability	492	1978									

Table 9 Cluster and term specification Sustainability

Search term: Resilience 1990-2017

WoS categories excluded from search

Clinical Neurology	Gerontology/Geriatrics	Pediatrics	Health Care Sciences Services	Dentistry Oral Surgery Medicine
Psychiatry	Genetics Heredity	Family Studies	Nursing	Sport Sciences
Psychology Appled	Social Work	Oncology	Psychology Experimental	Substance Abuse
Public Environmental Occupational Health	Psychology Developmental	Medicine General Internal	Psychology Educational	Psychology Social
Psychology/ Psychology Multidisciplinary	Neurosciences	Hospitality Leisure Sport Tourism	Health Policy Services	Surgery
Psycholofy Clinical	Rehabiliatation	Endocrinology Metabolism	Geriatrics/Gerontology	Pharmacology/Pharmacy

Table 9 WoS categories excluded from search term Resilience

Evolution timeline

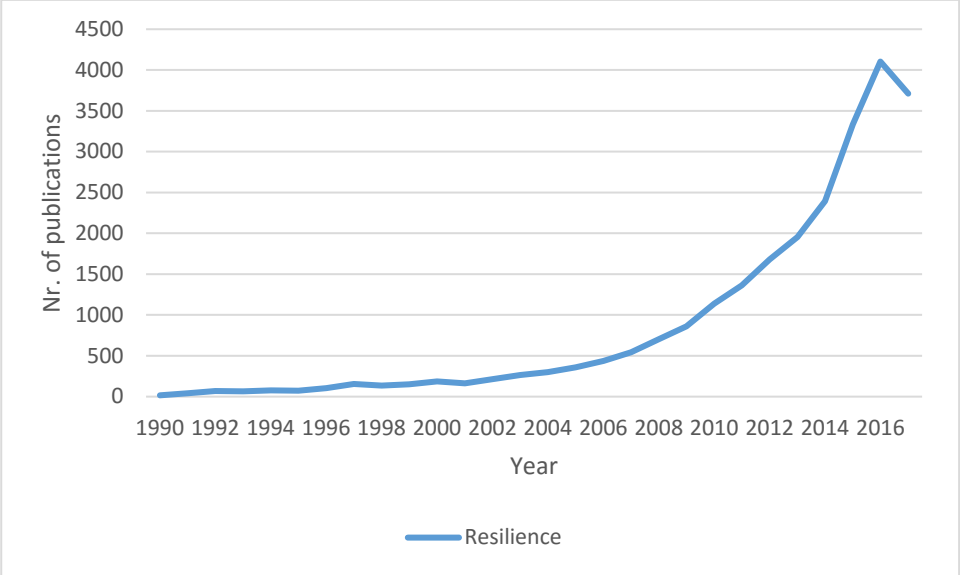

Fig. 9 Evolution of research on resilience

Top 10 Research areas

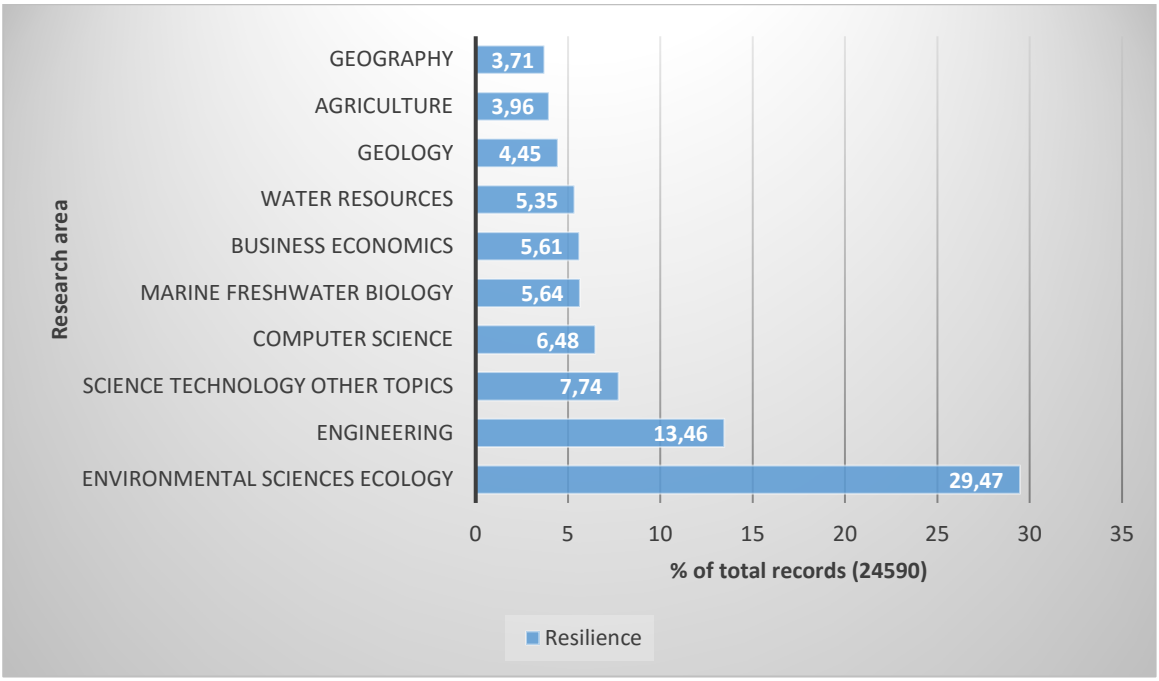

Fig. 10 Top 10 Research Areas in the context of resilience

Network visualization

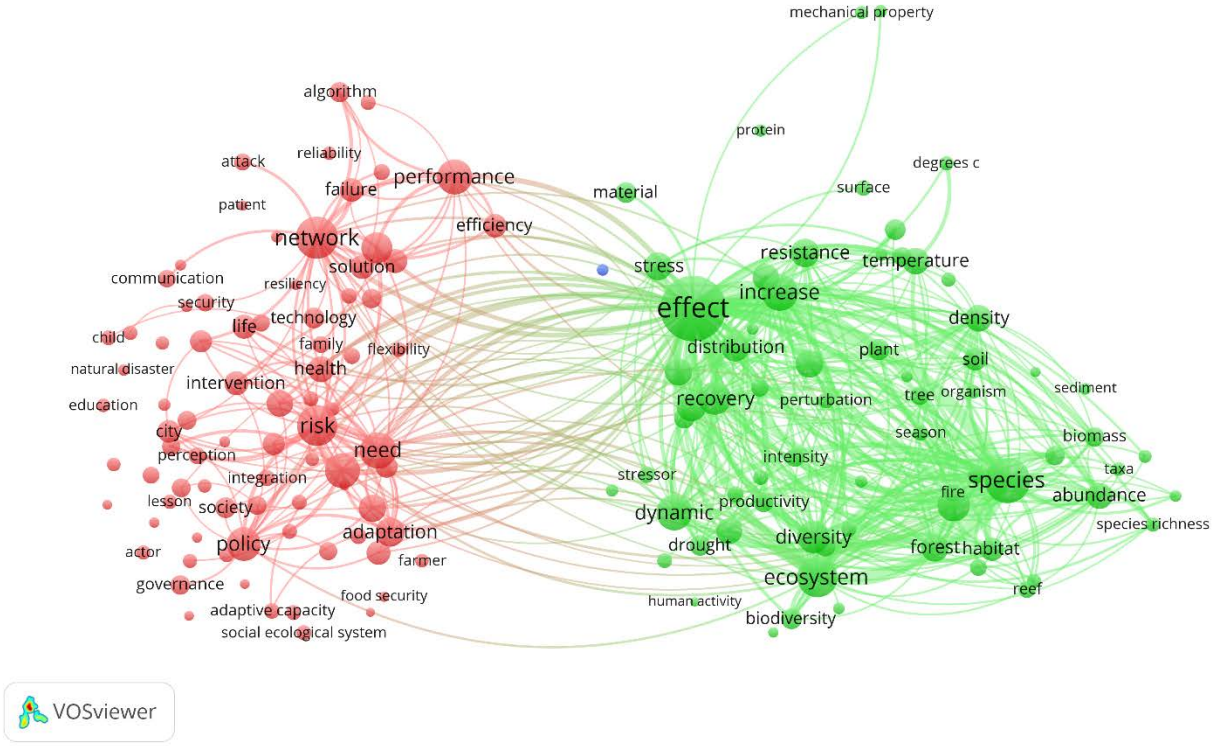

Fig. 11 Network visualization of Resilience

Cluster and term specification

	Cluster 1			Cluster 2	
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Action	1392	8526	Abundance	1256	9810
Actor	489	2763	Animal	334	2116
Adaptability	275	1570	Availability	880	6396
Adaptation	1576	9957	Biodiversity	894	6947
Adaptive capacity	561	3737	Biomass	795	6401
Agency	626	3379	Carbon	471	3368
Algorithm	831	3169	Community structure	427	3363
Attack	625	2576	Concentration	879	5398
Awareness	391	2357	Coral reef	485	3830
Building	740	4272	Crop	385	2748
Business	325	1818	Decline	896	6693
Child	504	2229	Decrease	744	5144
City	1050	5773	Degrees c	495	3071
Climate change adaptation	251	1697	Density	1323	9222
Communication	685	3416	Distribution	1467	9185
Community resilience	513	2891	Disturbance	1851	14088

Conflict	446	2412	Diversity	1849	13293
Cost	1102	6155	Drought	881	6916
Crisis	768	3766	Dynamic	2168	13724
Culture	534	2558	Ecosystem	2644	19379
Decision	972	5887	Ecosystem resilience	354	2733
Decision making	516	3343	Effect	5962	35499
Depression	347	1679	Environmental condition	393	2854
Design	1703	9070	Fire	675	5094
Disruption	561	3092	Fish	645	4885
Earthquake	445	2481	Fishing	291	2238
Economy	740	3993	Forest	1412	10713
Education	454	2355	Growth	1631	10691
Effectiveness	814	4501	Habitat	1072	8296
Efficiency	1056	5810	Hardness	367	1222
Error	501	1798	High resilience	341	2175
Failure	1052	5098	Human activity	231	1659
Family	644	3379	Increase	2236	14765
Farmer	450	2939	Intensity	757	5571
Flexibility	506	2774	Island	512	3485
Food security	278	2027	Material	884	4296
Governance	798	4712	Mechanical property	426	1486
Hazard	726	4590	Mortality	611	4800
Health	1282	7185	Nutrient	293	2328
Household	468	2950	Organism	444	3267
Identity	430	2057	Persistence	510	3433
Industry	579	3126	Perturbation	601	3889
Infrastructure	972	5711	Plant	911	6614
Integration	608	3481	Precipitation	354	2775
Intervention	1148	6412	Productivity	794	6036
Lesson	466	2695	Protein	390	1546
Life	1132	5727	Recovery	1921	12644
Livelihood	522	3757	Reef	612	4636
Man	339	1793	Resistance	1476	9236
Mitigation	448	3090	Restoration	610	4211
Natural disaster	361	2175	River	510	3604
Natural resource	236	1631	Season	572	4283
Need	2197	13299	Sediment	352	2557
Network	2828	13247	Shift	1277	8843
Outcome	1319	7325	Soil	1018	7254
Participation	458	2548	Species	3260	23509
Patient	298	1158	Species composition	344	2983
Perception	650	3560	Species richness	496	4386
Performance	2104	9840	Stability	1317	7788
Policy	1961	11262	Stress	1432	8582
Policy maker	299	1792	Stressor	582	4084
Poverty	273	1722	Surface	539	2946
Power	660	3176	Survival	663	4412
Reliability	441	2242	Taxa	444	3476
Resiliency	286	1533	Temperature	1347	8837
Risk	2613	15411	Tree	755	5755
Robustness	579	2919	Variation	1462	9651
Safety	313	1660	Vegetation	783	5936
Science	728	4135	Water	1400	9367
Security	654	3334			

Shock	513	2816			
Social capital	251	1486			
Social ecological system	531	3208	* Redundancy	353	2173
Society	906	5276			
Solution	1110	5817			
Sustainability	1133	6719			
Sustainable development	269	1671			
Technology	872	4779			
Transformation	574	3206			
Uncertainty	957	5861			
Vulnerability	2114	2114			
Woman	467	2210			

Table 10 Cluster and term specification Resilience

Search term: Risk AND Sustainability 1990-2017

WoS Categories excluded from search

Pediatrics	Psychiatry	Psychology Clinical	Nursing	Endocrinology Metabolism
Education Educational Research	Plant Sciences	Social Issues/ Social Work	Medicine Research Experimental	Surgery
Zoology	Respiratory System	Cardiac Cardiovascular Systems	Medicine General Internal	Entomology
Immunology	Tropical Medicine	Psychology Applied	Oncology	Gerontology

Table 11 WoS categories excluded from search term Risk AND Sustainability

Evolution timeline

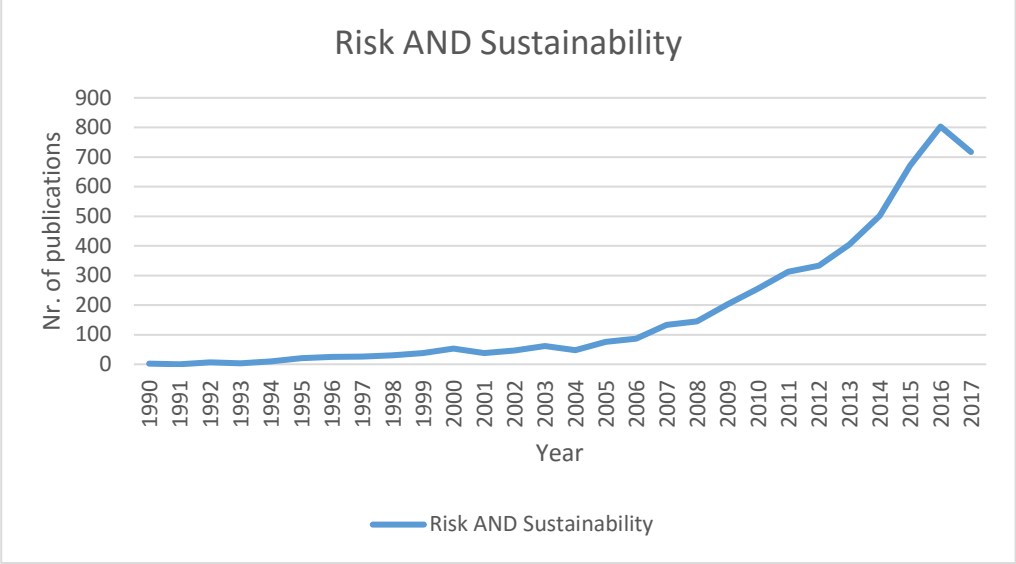

Fig. 12 Evolution of research in the context of Risk AND Sustainability

Top 10 Research Areas

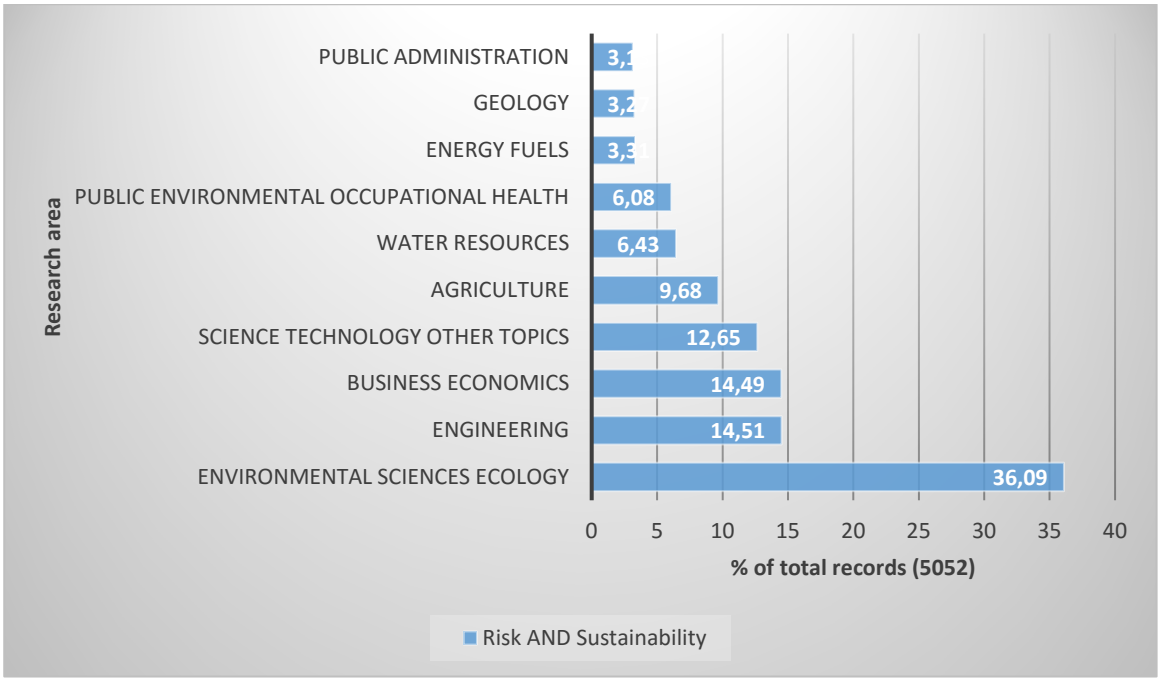

Fig. 13 Top 10 Research Areas in the context of Risk AND Sustainability

Network Visualization

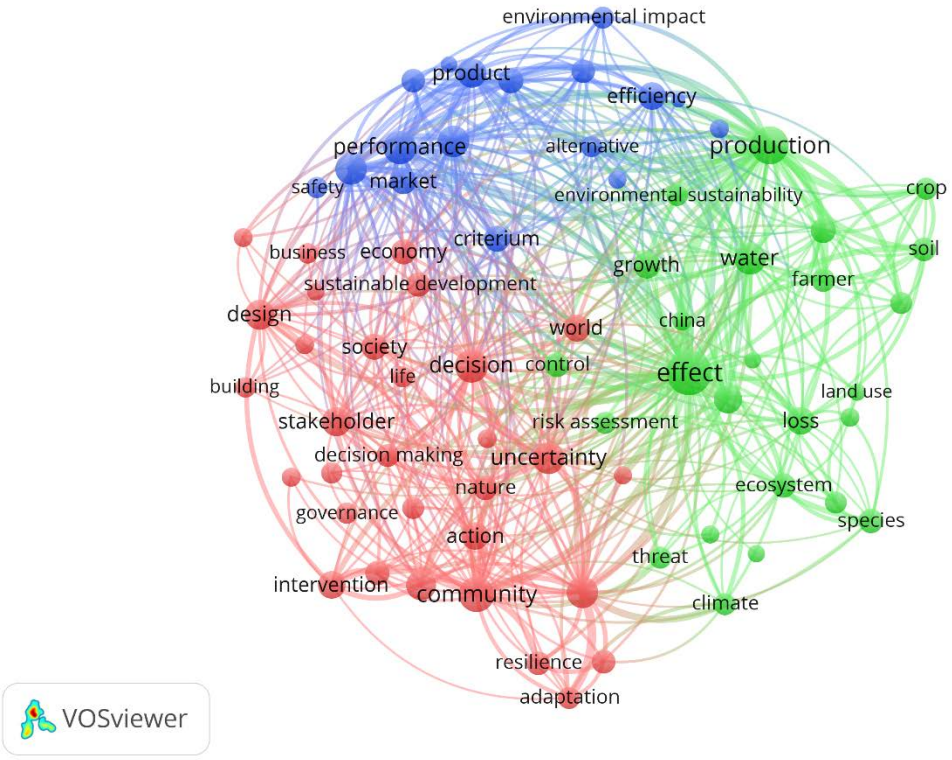

Fig. 14 Network visualization Risk AND Sustainability

Cluster and term specification

Cluster 1			Cluster 2			Cluster 3		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Action	365	1824	Agriculture	305	1732	Alternative	216	1116
Adaptation	242	1376	Biodiversity	174	1008	Consumer	140	688
Awareness	172	889	China	196	846	Criterium	323	1473
Building	201	969	Climate	237	1361	Efficiency	381	1931
Business	202	957	Conservation	244	1188	Emission	269	1475
Climate change	483	2672	Control	296	1291	Energy	307	1696
Community	603	2613	Crop	238	1247	Environmental impact	243	1306
Complexity	175	909	Ecosystem	301	1500	Environmental risk	160	809
Conflict	160	812	Effect	996	4343	Food	176	963
Decision	528	2500	Environmental sustainability	228	1114	Human health	102	563
Decision making	255	1307	Farmer	270	1378	Industry	497	2415
Design	447	2015	Growth	355	1619	Market	342	1475
Economy	310	1498	Land use	155	833	Material	276	1442
Education	180	759	Long term	136	702	Performance	538	2186

Effectiveness	292	1219	Long term sustainability	147	596	Product	416	2181
Evidence	444	1746	Loss	367	1829	Safety	220	990
Governance	220	1003	Probability	164	645	Technology	477	2363
Innovation	185	940	Production	711	3738			
Intervention	378	1462	Productivity	233	1254			
Life	222	1056	Risk assessment	241	1014			
Nature	289	1369	Scenario	392	1973			
Perception	249	1134	Soil	281	1356			
Resilience	272	1332	Species	297	1244			
Risk management	229	1019	Threat	249	1244			
Society	332	1615	Water	474	2349			
Stakeholder	408	1894						
Sustainable development	287	1263						
Transition	149	703						
Uncertainty	481	2239						
Vulnerability	268	1203						
World	346	1707						

Table 12 Cluster and term specification Risk AND Sustainability

Search term: Risk AND Resilience 1990-2017

WoS categories excluded from search

Psychiatry	Health Policy Services	Immunology	Medicine Research Experimental	Cell Biology
Psychology Educational	Family Studies	Clinical Neurology	Pharmacology/ Pharmacy	Urology Nephrology
Gerontology/Geriatrics	Psychology Multidisciplinary	Education Special	Obstetrics Gynecology	Parasitology
Psychology Developmental	Neurosciences	Pediatrics	Plant Sciences	Rheumatology
Substance Abuse	Psychology Applied	Ergonomics	Medicine General Internal	Orthopedics
Genetics Hereditary	Infectious Diseases	Psychology Social	Endocrinology Metabolism	Dentistry Oral Surgery Medicine
Psychology Clinical	Psychology	Evolutionary Biology	Social Issues	Zoology
Psychology Experimental	Hospitality Leisure Sport Tourism	Nursing	Cardiac Cardiovascular Systems	Emergency Medicine
Social Work	Education/Educational Research	Nutrition Dietetics	Sport Sciences	
Rehabilitation	Surgery	Oncology	Physiology	

Table 13 WoS categories excluded from search term Risk AND Resilience

Evolution timeline

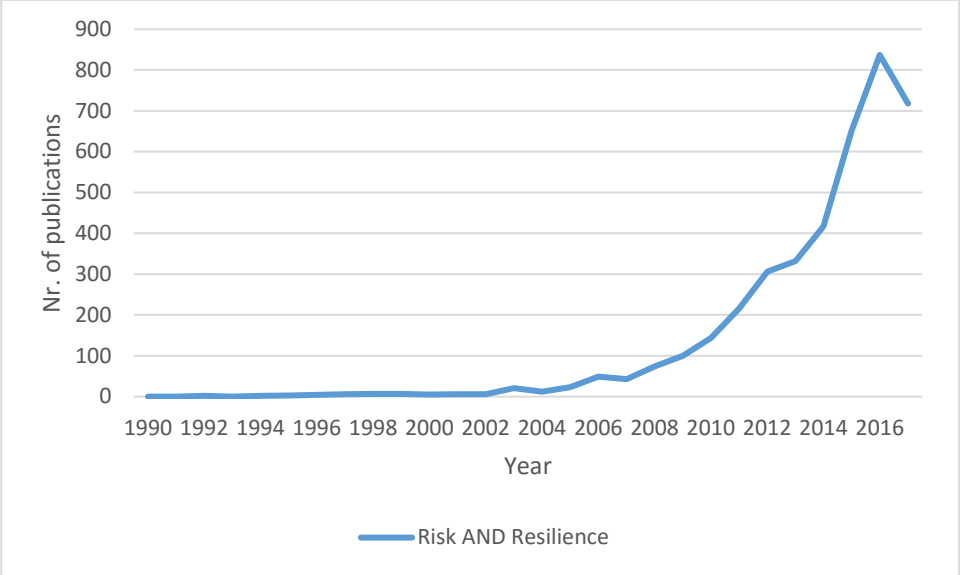

Fig. 15 Evolution of research in the context of Risk AND Resilience

Top 10 Research Areas

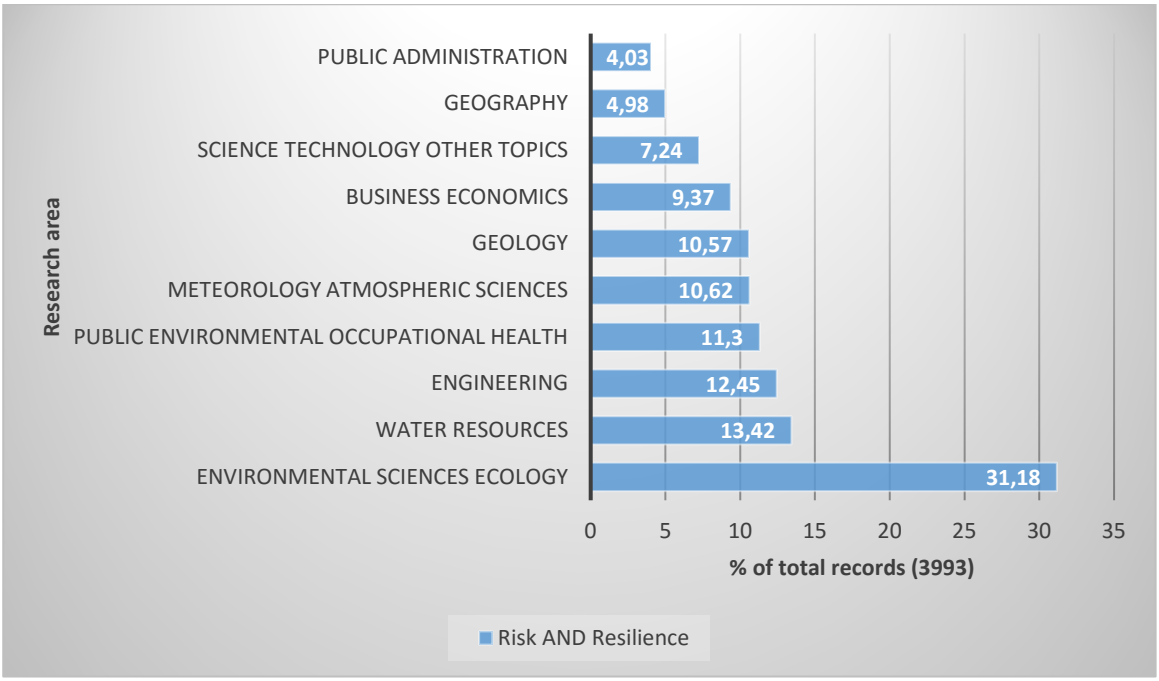

Fig. 16 Top 10 Research Areas in the context of Risk AND Resilience

Network visualization

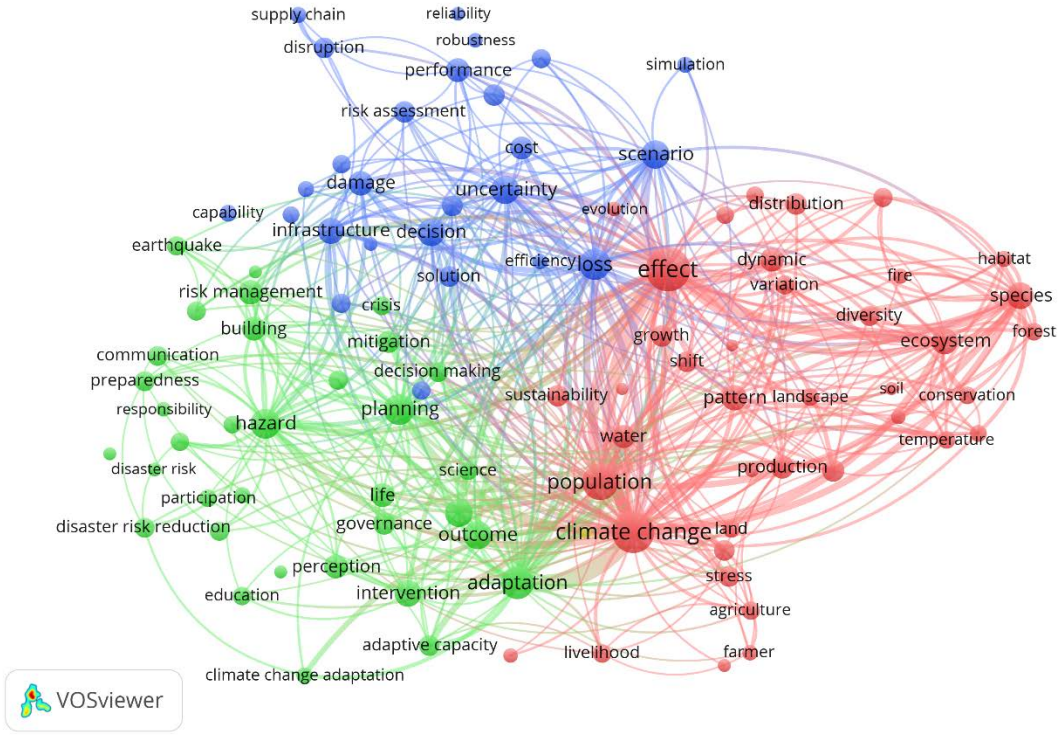

Fig. 17 Network visualization Risk AND Resilience

Cluster and term specification

Cluster 1			**Cluster 2**			**Cluster 3**		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Agriculture	124	837	Adaptation	405	2431	Capability	108	497
Biodiversity	108	808	Adaptive capacity	163	941	Complexity	164	913
Climate change	670	4039	Building	210	1171	Cost	197	1041
Conservation	123	841	Climate change adaptation	102	627	Damage	230	1298
Distribution	178	980	Communication	149	747	Decision	287	1594
Disturbance	140	846	Community resilience	135	709	Decision maker	103	627
Diversity	153	899	Crisis	145	538	Disruption	162	697
Drought	162	1032	Culture	98	362	Efficiency	92	547
Dynamic	217	1216	Decision making	156	941	Extreme event	75	497
Ecosystem	263	1757	Disaster resilience	65	304	Failure	178	824
Ecosystem service	81	569	Disaster risk	72	412	Industry	126	624

Effect	736	3734	Disaster risk reduction	153	746	Infrastructure	258	1437
Evolution	80	415	Earthquake	138	690	Investment	124	739
Farmer	92	535	Education	129	542	Loss	377	2180
Fire	92	562	Exposure	279	1390	Performance	216	1008
Food security	68	438	Flood risk management	64	353	Probability	142	760
Forest	122	818	Governance	193	1027	Reliability	75	363
Growth	171	982	Hazard	328	1931	Risk assessment	172	930
Habitat	95	676	Integration	145	800	Robustness	78	387
Human	61	345	Intervention	273	1154	Safety	113	564
Land	116	793	Life	213	898	Scenario	303	1843
Land use	79	527	Mitigation	183	1124	Security	145	677
Landscape	118	756	Natural disaster	135	764	Simulation	103	568
Livelihood	134	875	Natural hazard	124	725	Solution	162	873
Long term	54	343	Outcome	299	1296	Supply chain	99	401
Pattern	235	1315	Participation	123	578	Uncertainty	309	1744
Population	487	2595	Perception	207	943			
Poverty	85	462	Planning	348	2157			
Production	194	1118	Preparedness	147	859			
Resistance	115	632	Prevention	123	588			
Shift	161	961	Responsibility	86	448			
Soil	69	443	Risk management	225	1105			
Species	277	1715	Science	132	729			
Stability	117	547	Social capital	65	317			
Stress	168	799						
Sustainability	176	981						
Temperature	119	770	* Sea level rise	60	438			
Variability	190	1156						
Variation	136	830						
Water	194	1167						

Table 14 Cluster and term specification Risk AND Resilience

Search term: Risk AND Sustainability AND Resilience 1990-2017

WoS categories excluded from search

Education Educational Research	Immunology	Medicine General Internal	Infectious Diseases	Psychology Applied
Evolutionary Biology	Information Science/ Library Science	Nursing	Plant Sciences	Psychiatry
Family Studies	Medical Informatics	Pharmacology/ Pharmacy	Psychology	Zoology

Table 15 WoS categories excluded from search term Risk AND Sustainability AND Resilience

Evolution timeline

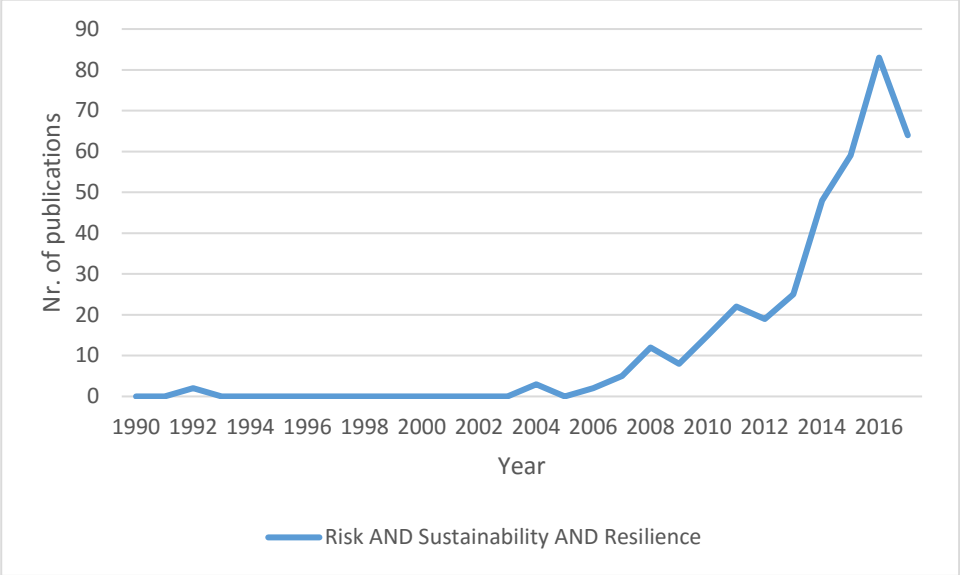

Fig. 18 Evolution of research in the context of Risk AND Sustainability AND Resilience

Top 10 Research Areas

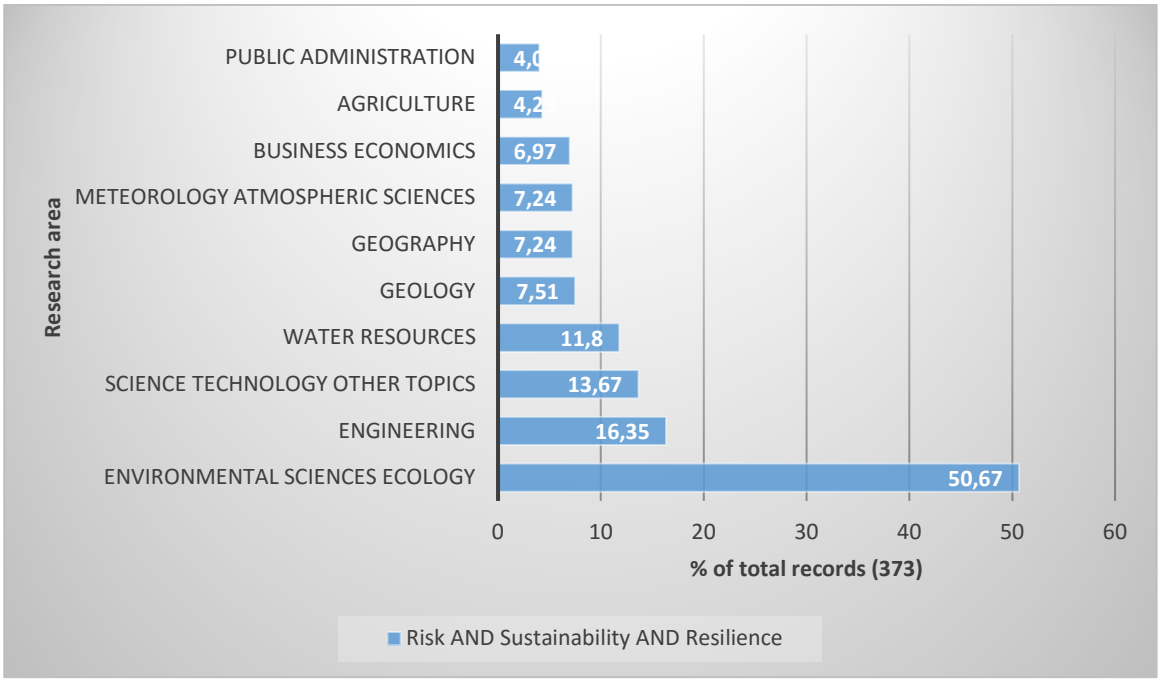

Fig. 19 Top 10 Research Areas in the context of Risk AND Sustainability AND Resilience

Network visualization

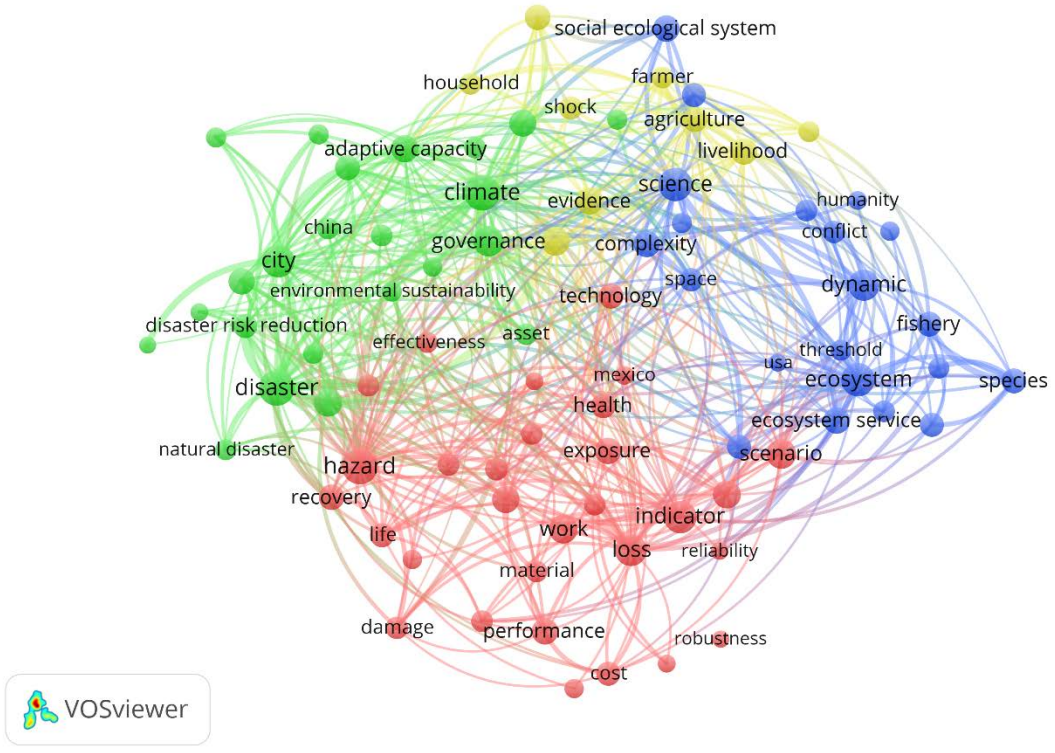

Fig. 20 Network visualization Risk AND Sustainability AND Resilience

Cluster and term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Community resilience	16	87	Adaptive capacity	25	113	Biodiversity	15	81	Agriculture	22	123
Cost	20	85	Asset	17	75	Complexity	24	114	Drought	28	140
Damage	18	90	China	17	84	Conflict	18	78	Evidence	26	130
Decision maker	16	91	City	37	167	Conservation	20	85	Farmer	17	87
Effectiveness	15	62	Climate	44	221	Decision making	20	109	Food security	15	81
Energy	16	92	Climate change adaptation	14	62	Dynamic	33	142	Household	16	78
Exposure	24	121	Climate change impact	14	79	Ecosystem	38	205	Livelihood	24	140
Failure	17	71	Disaster	43	217	Ecosystem service	24	116	Perception	23	96
Hazard	43	220	Disaster risk	11	64	Evolution	13	61	Shock	19	70
Health	21	111	Disaster risk reduction	20	102	Fishery	22	95			
Index	27	134	Environmental change	17	88	Human	17	89			
Indicator	36	178	Environmental sustainability	14	77	Humanity	12	61			
Infrastructure	26	121	Europe	13	73	Productivity	17	88			
Land use	13	77	Flood	27	138	Science	38	180			
Life	20	108	Governance	32	164	Social ecological system	24	95			
Long term	11	71	Government	22	132	Space	19	89			
Loss	35	183	Integration	25	121	Species	22	95			
Material	16	90	Intervention	24	112	Threshold	15	81			
Mexico	12	76	Natural disaster	15	86	Trade off	14	71			
Performance	24	97	Natural hazard	14	82	Transformation	20	97			
Probability	11	52	Policy maker	17	72	USA	11	48			
Quality	16	78	Transition	14	62						
Recovery	23	108	Urban resilience	10	43						

Reliability	11	58									
Risk assessment	13	44									
Robustness	10	43									
Scenario	30	146									
Sustainable development	18	83									
Technology	21	97									
Work	28	97									

Table 16 Cluster and term specification Risk AND Sustainability AND Resilience

2.4 Detailed Group 2 Search Terms for co-occurrence network of terms analysis

Search term: Ecological Resilience: 1990-2017

WoS categories excluded from search

None

Evolution timeline

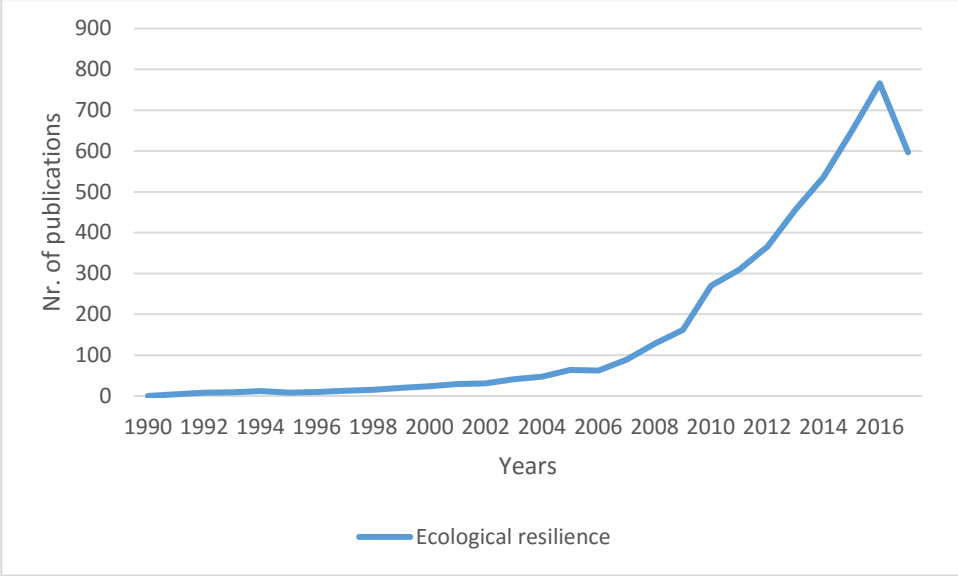

Fig. 21 Evolution of research in the context of Ecological resilience

Top 10 Research Areas

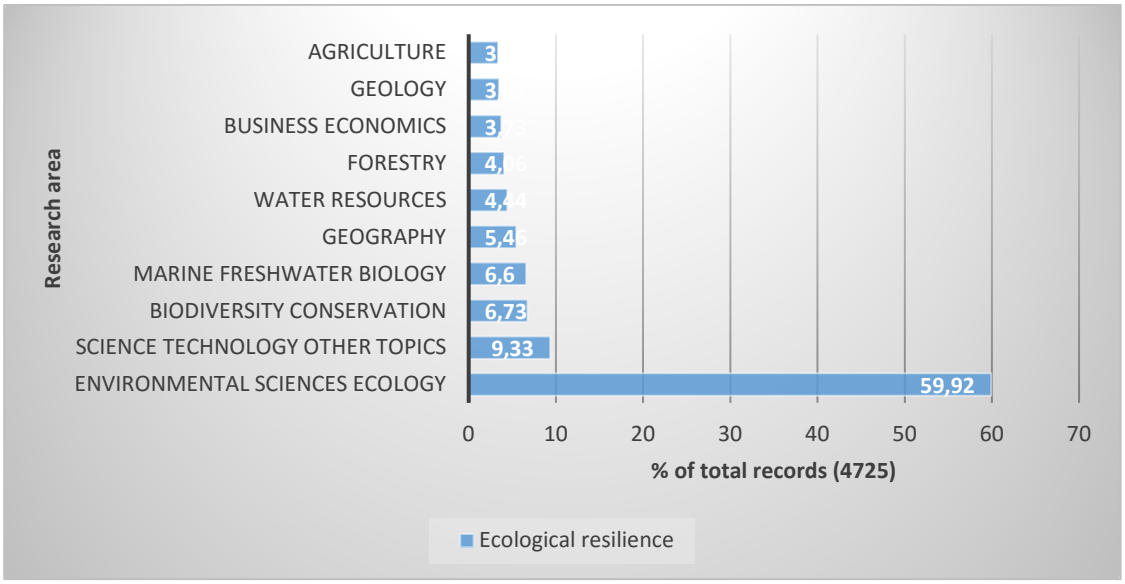

Fig. 22 Top 10 Research areas in the context of Ecological Resilience

Network visualization

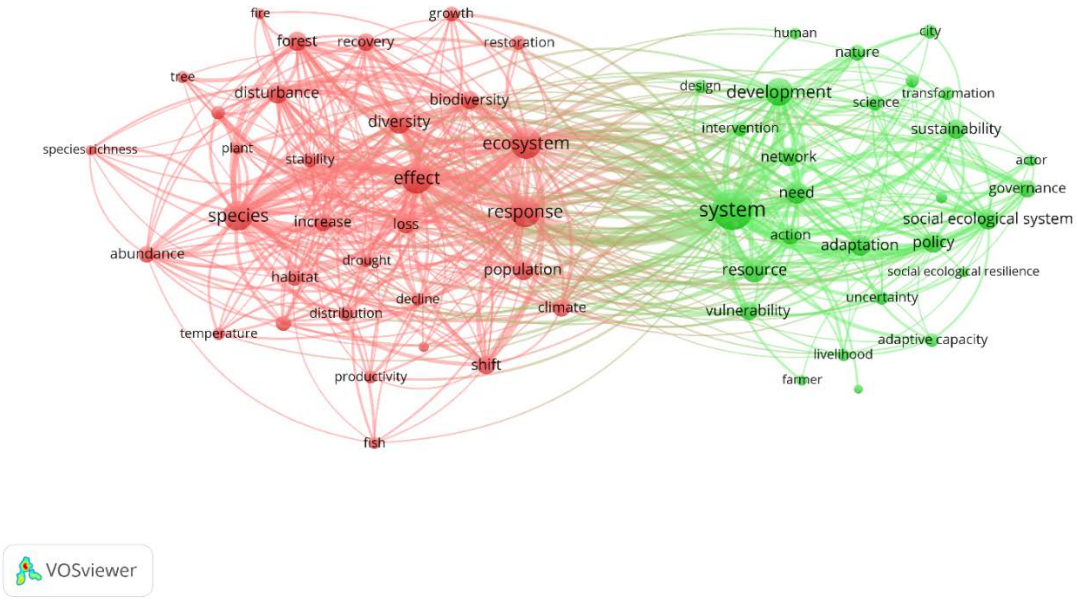

Fig. 23 Network visualization Ecological Resilience

Cluster and term specification

Cluster 1			Cluster 2		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Abundance	151	974	Action	169	918
Biodiversity	181	1187	Actor	91	492
Climate	177	1137	Adaptation	236	1290
Decline	101	713	Adaptive capacity	113	638
Distribution	138	850	City	120	498
Disturbance	229	1421	Decision making	78	411
Diversity	264	1610	Design	110	564
Drought	107	736	Development	381	1815
Ecosystem	465	2741	Farmer	77	405
Effect	471	2700	Food security	56	317
Environmental condition	71	431	Governance	173	893
Fire	74	496	Human	78	436
Fish	90	528	Intervention	128	655
Forest	206	1353	Livelihood	95	529
Growth	128	733	Nature	148	765
Habitat	149	917	Need	260	1426
Increase	184	1135	Network	194	942
Loss	174	1093	Policy	237	1211
Plant	88	539	Resource	295	1513
Population	226	1293	Science	129	660
Productivity	102	690	Social ecological resilience	67	325
Recovery	175	1032	Social ecological system	221	1151
Resistance	113	720	Society	102	573
Response	447	2598	Sustainability	207	968
Restoration	118	697	System	740	3679
Shift	190	1189	Transformation	103	553
Species	417	2505	Uncertainty	114	639
Species richness	70	523	Vulnerability	191	1012
Stability	125	744			
Temperature	99	617			
Tree	85	592			
Variation	135	820			

Table 17 Cluster and term specification Ecological Resilience

Search term: Spatial Resilience 1990-2017

WoS categories excluded from search

None

Evolution timeline

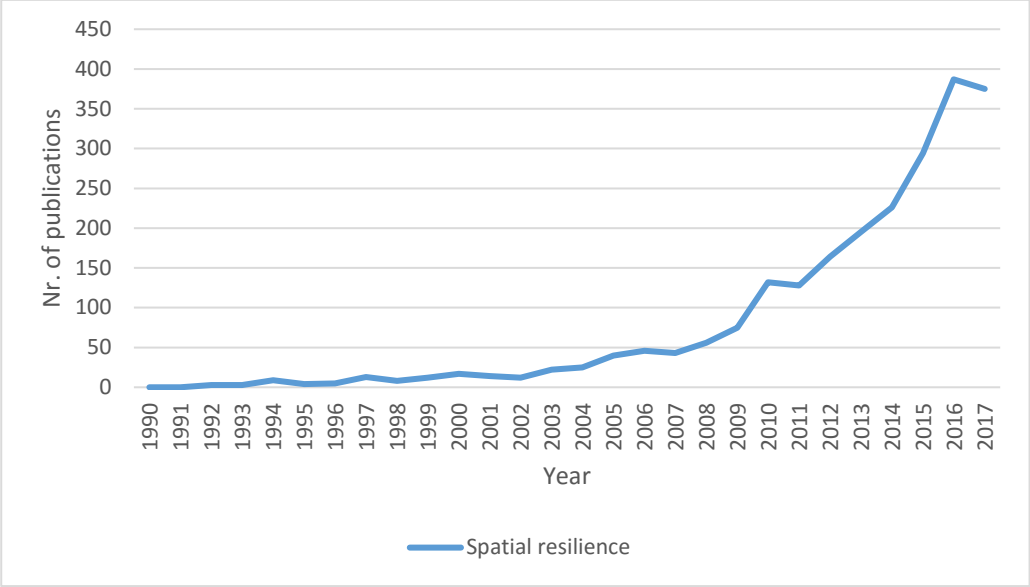

Fig. 24 Evolution of research in the context of Spatial Resilience

Top 10 Research Areas

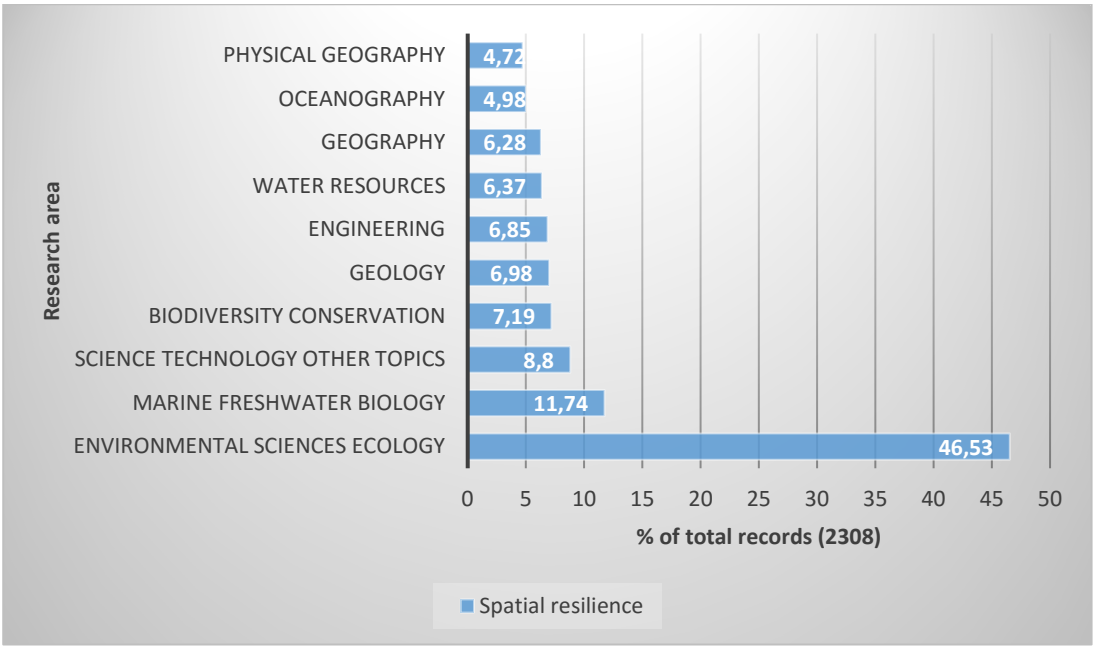

Fig. 25 Top 10 research areas in the context of Spatial Resilience

Network visualization

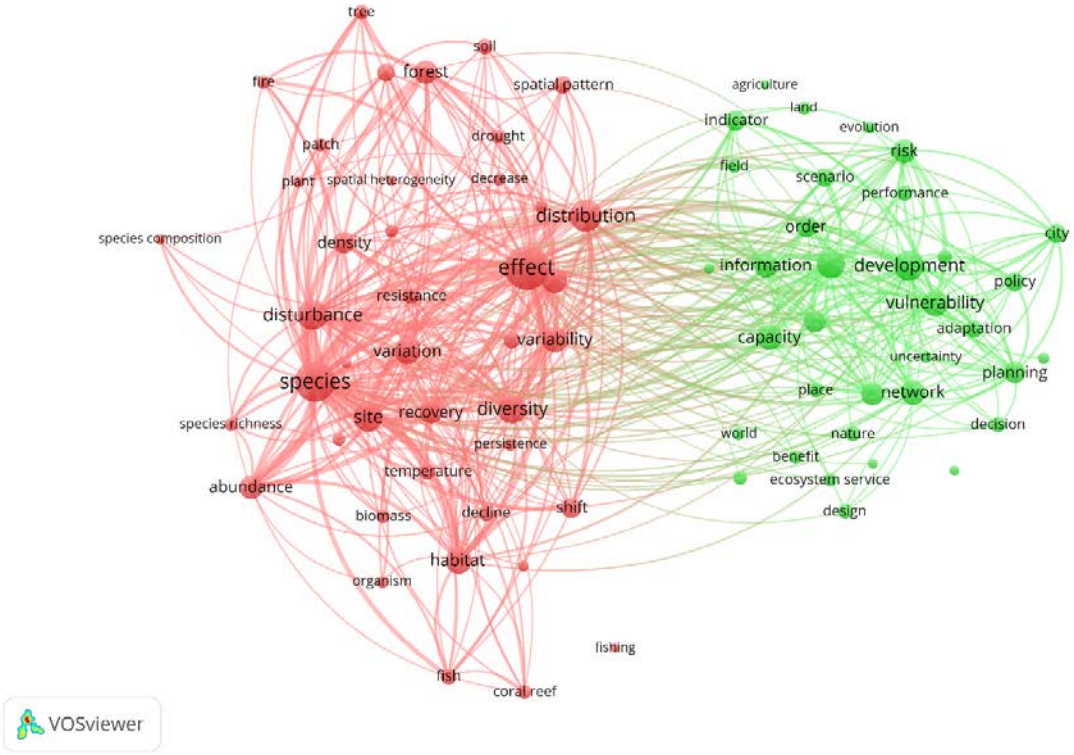

Fig. 26 Network visualization Spatial Resilience

Cluster and term specification

Cluster 1			Cluster 2		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Abundance	242	1703	Adaptation	150	891
Biomass	104	804	Agriculture	60	418
Coral reef	113	748	Benefit	105	636
Decline	139	963	Capacity	274	1600
Decrease	91	596	City	182	930
Density	217	1467	Decision	126	754
Distribution	396	2415	Design	123	741
Disturbance	370	2558	Development	367	2041
Diversity	343	2320	Ecosystem service	107	674
Drought	106	740	Evolution	82	476
Effect	667	4020	Field	113	585
Environmental condition	80	541	Flood	70	480
Fire	110	773	Human	64	345
Fish	137	934	Indicator	194	1187
Fishing	59	398	Information	258	1488
Forest	248	1719	Integration	84	491
Habitat	283	1966	Land	103	654
Increase	277	1826	Nature	126	755
Organism	92	636	Need	240	1434
Patch	108	713	Network	271	1345

Persistence	101	694	Order	209	1186
Plant	84	629	Performance	130	517
Productivity	99	660	Place	125	715
Recovery	238	1554	Planning	218	1306
Resistance	141	909	Policy	177	986
Season	102	699	Resource	221	1330
Shift	197	1254	Risk	244	1433
Site	338	2246	Scenario	168	1117
Soil	127	900	Social ecological system	67	399
Spatial heterogeneity	67	425	Strategy	327	2063
Spatial pattern	162	1004	Sustainability	117	641
Spatial variation	100	633	Temporal scale	106	627
Species	575	3935	Uncertainty	83	518
Species composition	68	545	Vulnerability	289	1621
Species richness	101	842	World	102	625
Stability	142	908			
Temperature	144	903			
Temporal variation	60	400			
Tree	119	886			
Variability	280	1737			
Variation	272	1714			
Vegetation	166	1130			

Table 18 Cluster and term specification Spatial Resilience

Engineering Resilience 1990-2017

WoS Categories excluded from search

~~Cell Biology~~	~~Education/ Educational Research~~	~~Ergonomics~~	~~Psychology Experimental~~	~~Social Issues~~
~~Evolutionary Biology~~	~~Psychology Applied~~	~~Plant Sciences~~	~~Psychology Social~~	

Table 19 WoS categories excluded from search term Engineering Resilience

Evolution Timeline

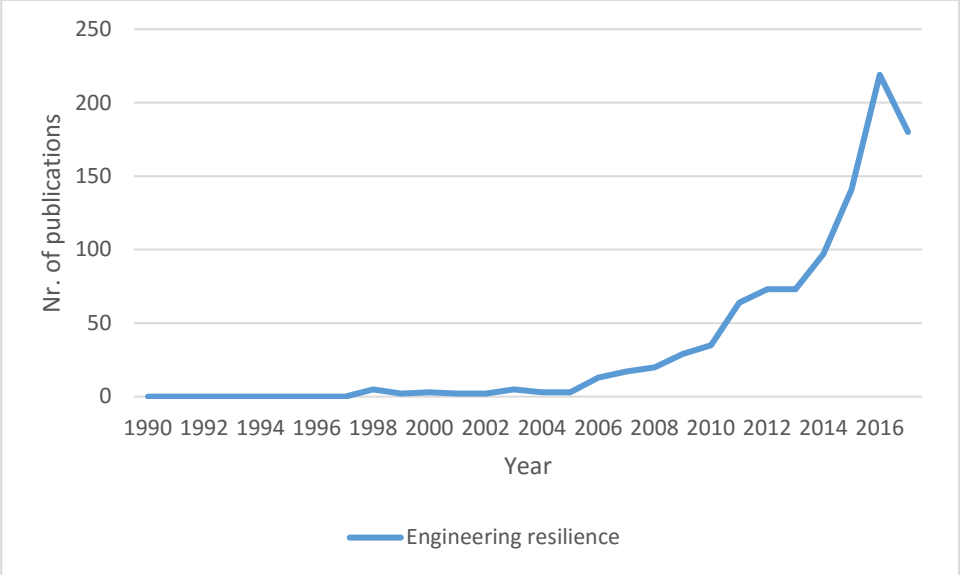

Fig. 27 Evolution of research in the context of Engineering Resilience

Top 10 Research Areas

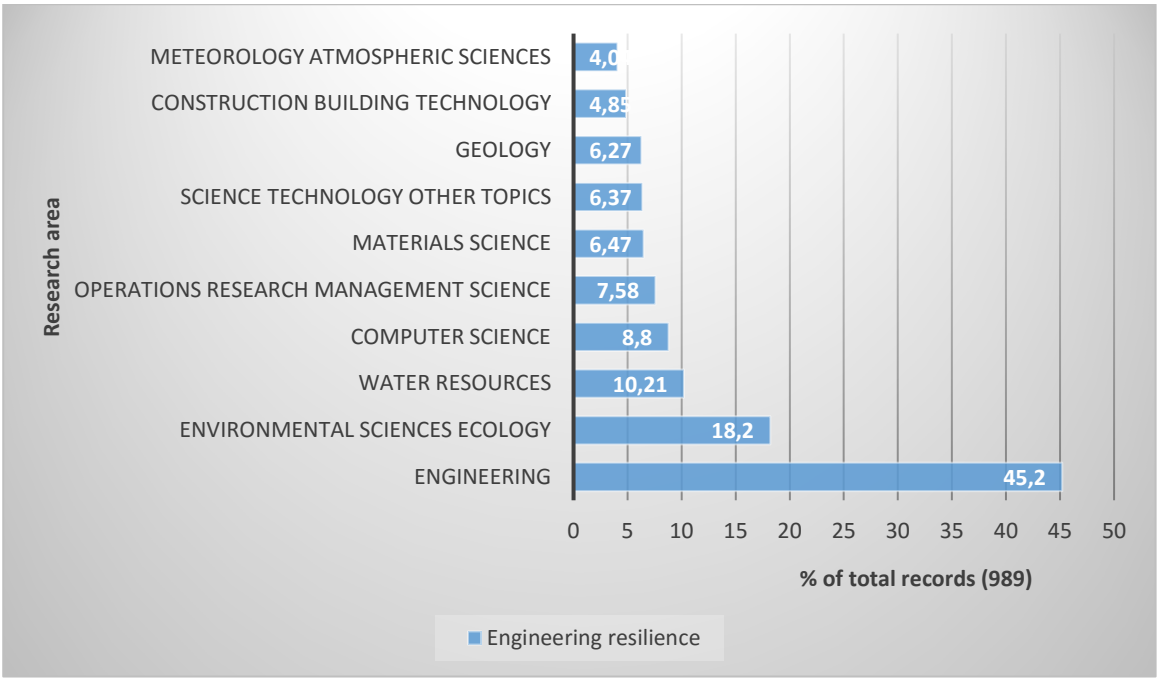

Fig. 28 Top 10 Research Areas in the context of Engineering Resilience

Network visualization

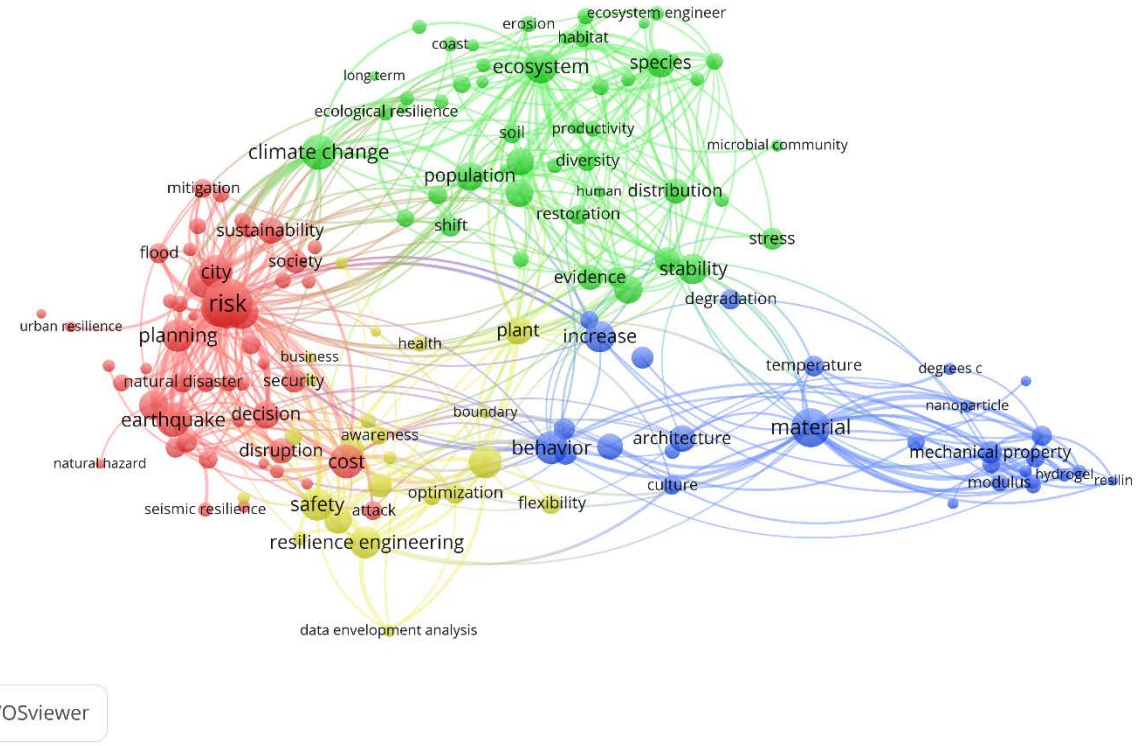

Fig. 29 Network visualization Engineering Resilience

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Agency	25	153	Abundance	25	188	Agent	22	96	Accident	20	96
Attack	29	107	Agriculture	20	121	Architecture	50	172	Adaptability	12	60
Bridge	25	138	Biodiversity	23	180	Behavior	71	354	Adaptive capacity	16	90
City	71	387	Biomass	18	110	Cell	26	146	Algorithm	43	163
Collaboration	18	91	Climate change	78	453	Compliance	13	54	Awareness	29	158
Community resilience	19	89	Coast	21	137	Culture	30	180	Boundary	14	58
Cost	72	368	Conservation	16	117	Degradation	33	194	Business	14	56
Critical infrastructure	18	98	Coral reef	11	72	Degrees c	16	81	Complex system	28	153

Decision	53	300	Decline	17	134	Elasticity	19	114	Data envelopment analysis	15	87
Decision maker	18	121	Distribution	46	263	Energy	48	212	Efficiency	71	332
Decision making	24	155	Disturbance	55	322	Exposure	28	165	Expert	20	110
Disaster resilience	16	87	Diversity	32	206	High resilience	12	81	Flexibility	34	165
Discussion	29	145	Drought	16	109	Hydrogel	17	108	Health	23	111
Disruption	46	198	Dynamic	55	306	Increase	64	332	Industry	45	214
Earthquake	74	378	Ecological resilience	25	163	Load	39	175	Optimization	35	189
Economy	24	157	Ecology	29	155	Material	91	450	Plant	55	360
Engineering design	14	53	Ecosystem	73	538	Mechanical property	39	228	Redundancy	26	131
Extreme event	26	169	Ecosystem engineer	19	154	Modulus	27	130	Reliability	55	238
Fire	12	70	Ecosystem service	19	146	Nanoparticle	15	85	Resilience engineering	66	267
Flood	32	193	Emergence	10	55	Poly	15	90	Resiliency	16	73
Governance	22	102	Engineering resilience	27	145	Product	36	161	Resilient system	13	59
Hazard	58	349	Erosion	23	153	Protein	33	175	Safety	70	333
Infrastructure system	32	185	Evidence	46	277	Resilin	11	78	System design	17	82
Innovation	14	68	Feedback	24	137	Scaffold	22	130	System resilience	22	91
Investment	24	137	Flow	32	140	Strain	27	156			
Lesson	20	95	Growth	46	314	Temperature	35	168			
Mitigation	29	160	Habitat	28	222	Tissue	29	174			
Natural disaster	34	205	Human	13	66	Tissue engineering	18	119			
Natural hazard	11	71	Landscape	27	183	Variety	38	193			
Planning	68	368	Long term	11	65						
Policy	71	374	Microbial community	15	89						
Preparedness	30	205	Modification	21	127						
Probability	33	190	Organism	19	124						
Reconstruction	14	69	Perturbation	23	133						
Risk	134	721	Population	56	383						
Risk assessment	33	191	Productivity	23	142						

Risk management	25	140	Resistance	56	332						
Security	41	184	Restoration	31	200						
Seismic resilience	19	73	River	20	133						
Social science	11	40	Sea level rise	19	110						
Society	42	267	Shift	34	217						
Sustainability	50	285	Soil	31	193						
Sustainable development	11	67	Species	57	401						
Transportation	16	75	Stability	62	291						
Uncertainty	72	410	Stress	38	206						
Urban resilience	13	87	Survival	20	135						
Utility	15	85	Transformation	13	76						
Vulnerability	96	525	Transition	20	122						
Water supply	19	98	Vegetation	13	91						

Table 20 Cluster and term specification Engineering Resilience

Search term: Infrastructure resilience 1990-2017

WoS Categories excluded from search

Psychiatry	Psychology Applied	Social Work	Medicine General Internal	Geriatrics/ Gerontology
Plant Sciences	Psychology Clinical	Ergonomics	Nursing	Immunology

Table 21 WoS categories excluded from search term Infrastructure resilience

Evolution Timeline

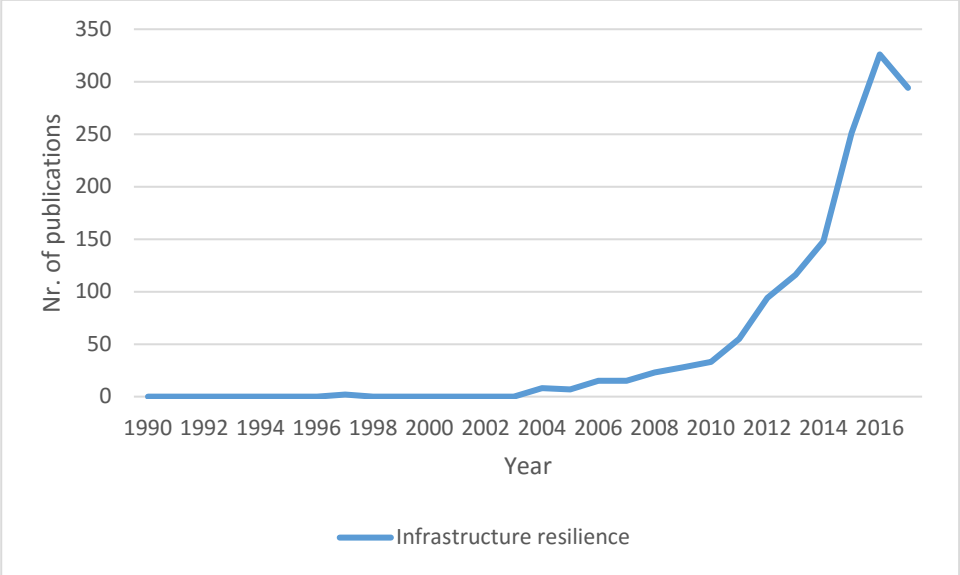

Fig. 30 Evolution of research in the context of Infrastructure resilience

Top 10 Research Areas

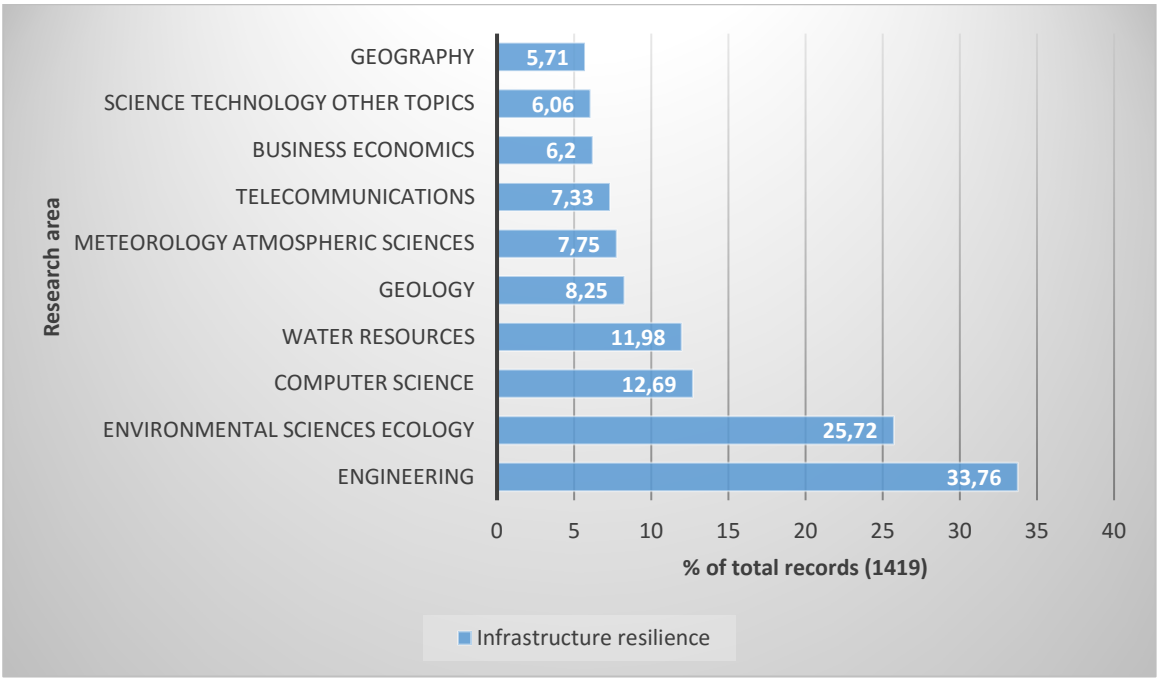

Fig. 31 Top 10 Research Areas in the context of Infrastructure Resilience

Network visualization

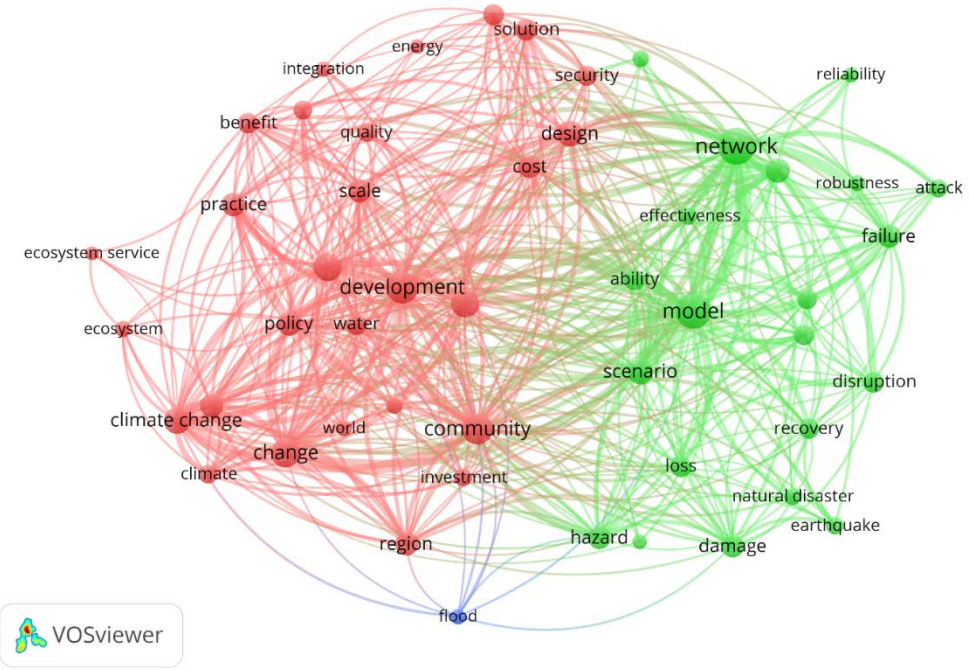

Fig. 32 Network visualization Infrastructure Resilience

Cluster and Term specification

Cluster 1			**Cluster 2**		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Adaptation	153	873	Ability	128	671
Benefit	123	659	Attack	96	405
Change	238	1251	Complexity	84	418
City	222	1112	Critical infrastructure	116	546
Climate	101	609	Damage	148	739
Climate change	206	1182	Disruption	128	626
Community	273	1364	Earthquake	87	458
Cost	155	810	Effectiveness	91	475
Design	195	954	Extreme event	61	358
Development	295	1522	Failure	157	753
Ecosystem	74	450	Hazard	145	799
Ecosystem service	58	292	Infrastructure system	118	647
Energy	63	340	Loss	130	699
Evidence	77	441	Model	370	1754
Integration	70	349	Natural disaster	84	461
Investment	92	529	Network	391	1737
Need	222	1157	Performance	179	840
Policy	167	903	Recovery	121	594
Practice	160	819	Reliability	71	371
Quality	95	497	Robustness	74	362
Region	159	862	Scenario	189	1045
Scale	153	789			

Security	120	561			
Solution	133	699			
Sustainability	107	545			
Technology	132	623			
Water	125	670			
World	77	427			

Table 22 Cluster and term specification Infrastructure Resilience

Search term: Robustness

WoS Categories excluded from search

Oncology	Psychology Experimental	Physiology	Zoology	Immunology
Medical Informatics	Plant Sciences	Chemistry Medicinal	Neuroimaging	Surgery
Health Care Sciences Services	Psychology Multidisciplinary	Audiology Speech Language Pathology	Education/ Educational Research	Psychiatry
Medicine Research Experimental	Pharmacology/ Pharmacy	Clinical Neurology	Medicine General Internals	

Table 23 WoS categories excluded from search term Robustness

Evolution Timeline

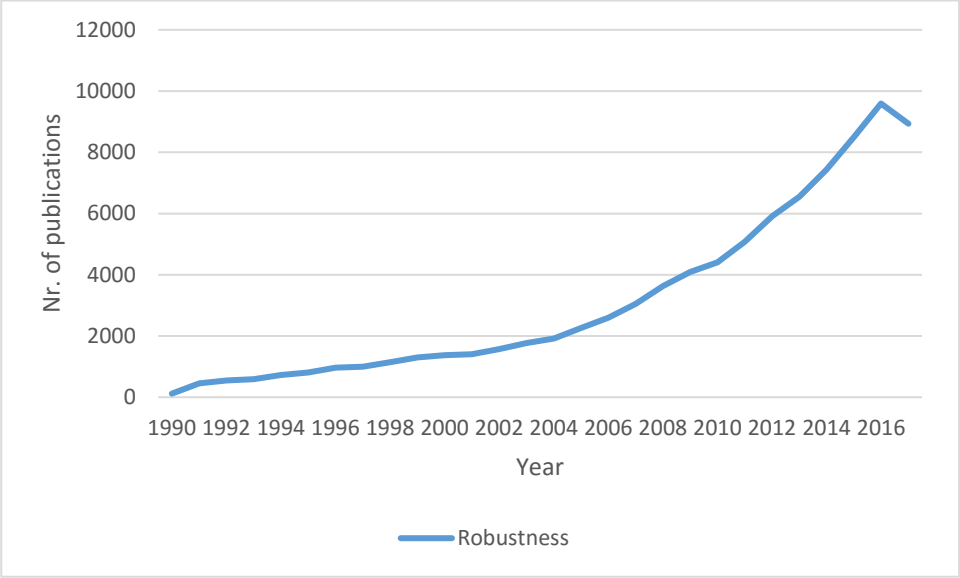

Fig. 33 Evolution of research in the context of Robustness

Top 10 Research Areas

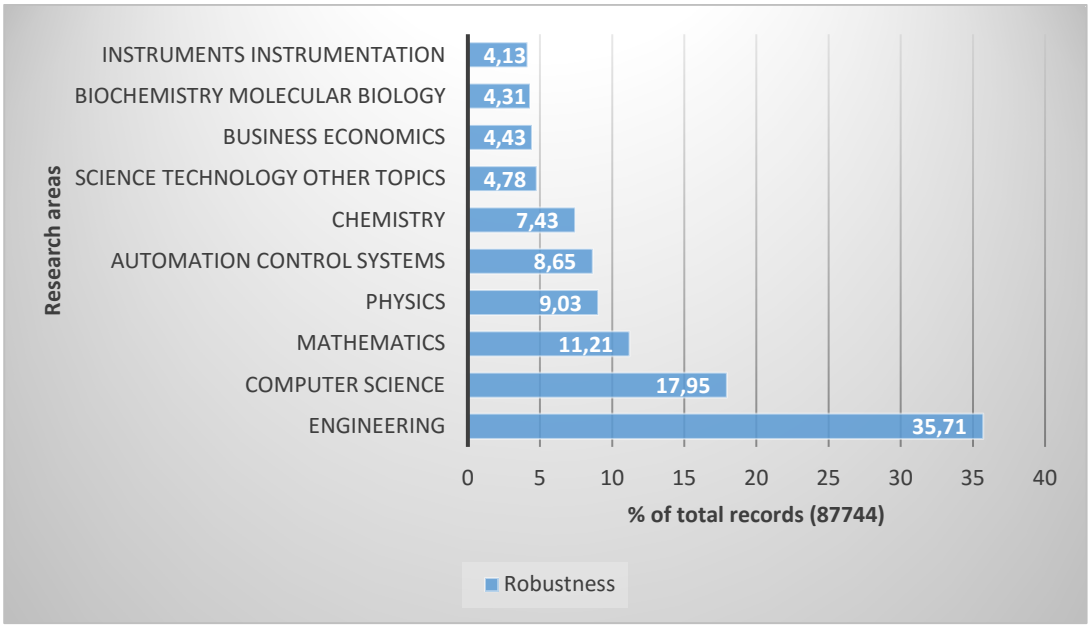

Fig. 34 Top 10 Research Areas in the context of Robustness

Network visualization

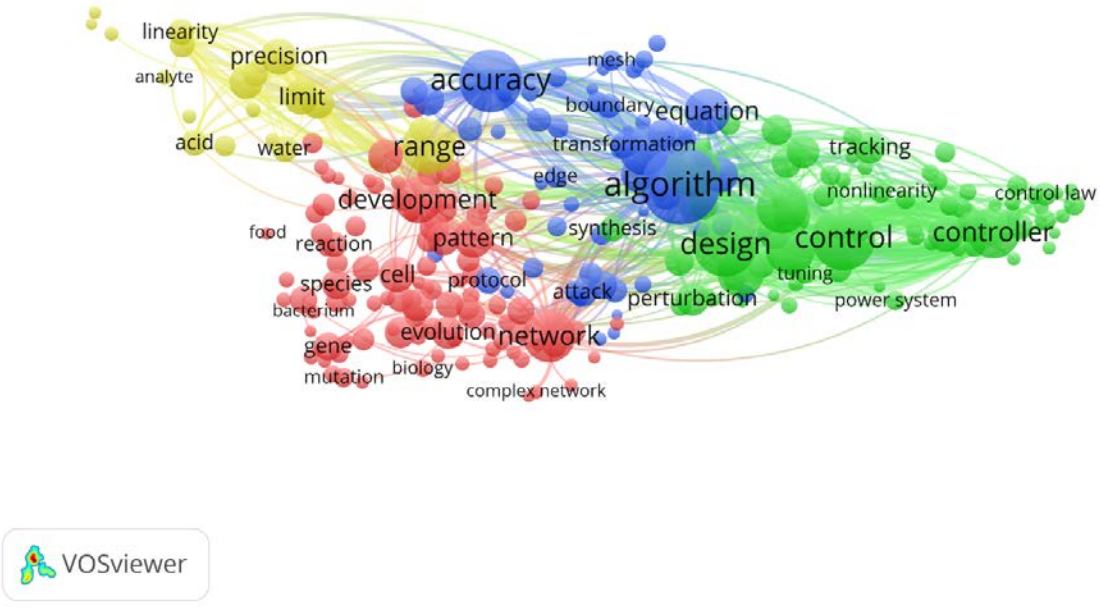

Fig. 35 Network visualization Robustness

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Abundance	436	2334	Actuator	807	5497	Accuracy	10345	47217	Acid	1526	10005
Adaptability	403	2258	Adaptive	504	2893	Algorithm	17101	68035	Analyte	441	3303
Agent	1054	5155	Adaptive control	442	3058	Architecture	1875	9324	Chromatographic separator	272	2577
Animal	425	2345	Chaos	285	1320	Attack	1804	6562	Column	1351	9735
Assembly	583	2628	Closed loop system	964	7126	Bandwidth	802	3569	Degradation	1252	6807
Assessment	2511	11461	Control	10837	62904	Boundary	1261	5177	Degrees C	969	5408
Bacterium	390	2525	Control algorithm	941	6494	Boundary condition	681	2800	Determination	2679	15804
Bias	1269	5020	Control law	1168	8282	Clustering	792	3084	Limit	2977	17156
Biological system	394	2524	Control scheme	1534	11323	Communication	1284	5717	Linearity	1454	11384
Biology	618	3700	Control system	2262	14829	Computation	2136	8827	Methanol	386	3311
Calibration	1050	4808	Controller	6875	44290	Computational complexity	668	2799	Oxidation	375	2452
Cell	2930	14830	Convergence	2557	12248	Correctness	245	1046	Plasma	445	2572
China	439	1825	Derivative	1131	6215	Deformation	839	3534	Precision	3019	19770
Climate change	357	1868	Design	10635	52323	Descriptor	682	2369	Quantitative analysis	379	2249
Community	1025	4972	Disturbance	3016	19798	Discontinuity	447	1849	Range	7467	37435
Complex network	410	2020	Disturbance rejection	338	2388	Distortion	1105	4190	Recovery	1627	10164
Complex system	297	1707	Dynamic	5342	30218	Edge	1043	3991	Separation	1460	8208
Composition	1101	5617	Dynamic model	539	3725	Energy consumption	319	1716	Simultaneous determination	291	2561
Confidence	421	1799	Effectiveness	6593	32698	Energy efficiency	238	1266	Statistical analysis	490	2293
Connectivity	569	2916	External disturbance	977	7889	Equation	5189	21201	Validation	2491	14541
Consequence	1219	5825	Fault	878	4617	Estimator	2716	8640	Water	1580	8521
Contamination	455	1873	Fault detection	341	1868	Extraction	1666	7614	Wavelength	647	3569
Cost effectiveness	299	1303	Feedback	1545	9076	Finite element method	595	2347			
Decision	1733	7408	Feedback control	502	3362	Generalization	585	2226			
Decision maker	357	1514	Force	1827	9940	Hardware	463	2439			
Decision making	461	2173	Fuzzy controller	345	2430	Interference	1329	6481			

Development	5484	28615	Fuzzy logic	285	1712	Learning	1133	5240			
Disease	1020	5328	Infinity	587	2986	Lifetime	384	1854			
Diversity	1032	5184	Initial condition	436	2275	Machine	1818	8459			
DNA	482	2545	Input	3090	17254	Maximum likelihood	357	1223			
Economy	550	2089	Instability	846	4152	Mesh	854	3452			
Emergence	378	2022	Linear matrix inequality	479	3191	Minimization	726	3140			
Emission	716	3169	Linear model	561	2522	Modulation	869	3497			
Enzyme	452	2668	Linear system	852	4340	Noise	6272	26045			
Escherichia coli	274	1797	Load	1902	9594	Noise ratio	894	3761			
Evidence	2460	9150	Lyapunov	257	1885	Noise robustness	342	1109			
Evolution	2348	11562	Mathematical model	926	5298	Noisy environment	244	960			
Exposure	613	2942	Model uncertainty	659	4112	Occlusion	566	2135			
Fitness	345	2084	Motion	2161	11055	Principal component analysis	442	1779			
Food	308	1790	Motor	914	6072	Prior knowledge	286	1382			
Functionality	646	3197	Neural network	2063	11029	Protection	857	3317			
Gene	1753	10001	Nonlinear system	923	5979	Protocol	1575	7140			
Genome	461	2826	Nonlinearity	1058	6293	Reconstruction	1320	5408			
Genotype	351	1984	Optimal design	385	1690	Residual	475	1820			
Growth	1623	7784	Optimization problem	1761	8003	Resolution	2269	10336			
Health	497	2495	Oscillation	1112	5910	Rotation	863	3592			
Heterogeneity	785	3479	Output	2560	14077	Scalability	686	3099			
Human	442	2402	Parameter uncertainty	591	3954	Scaling	515	2183			
Indicator	1117	4896	Parametric uncertainty	473	3307	Security	1017	3854			
Inference	1064	3867	Particle swarm optimization	551	2866	Sparsity	270	1075			
Instrument	670	2971	Perturbation	2596	13101	Speed	2996	15038			
Interpretation	977	4141	Power system	826	4852	Synchronization	643	2952			
Intervention	494	2256	Robot	1129	6186	Texture	389	1524			
Life	798	3979	Robust control	455	3121	Throughput	564	2768			
Light	1150	5060	Robust controller	410	3150	Tradeoff	597	2934			

Maintenance	483	2492	Robust design	349	1567	Transformation	1560	6403			
Material	2819	12105	Robust stability	474	2693	Transmission	1166	4927			
Mechanical robustness	515	1963	Robustness analysis	937	4569	Vector	1834	7707			
Model robustness	272	1141	Robustness property	1002	4395	Wireless sensor network	349	1796			
Molecule	1053	5039	Stability	7397	42166						
Monitoring	1415	7021	Stability analysis	640	3921						
Morphology	545	2335	Stability robustness	333	1852						
Mutation	839	5023	Stabilization	823	5003						
Network	7051	33517	Steady state	491	2617						
Network robustness	281	1386	Stiffness	454	2309						
Network topology	343	2038	Strong robustness	509	2864						
Organism	747	4850	Subsystem	470	2903						
Pathway	1024	6158	Sufficient condition	829	3938						
Pattern	3719	16412	Synthesis	1416	7367						
Phenotype	597	3817	System performance	534	2985						
Policy	1109	4377	System robustness	519	2881						
Polymer	470	2048	System uncertainty	256	2045						
Population	2230	10348	Tracking	2255	12724						
Precipitation	329	1476	Tracking error	357	2829						
Preference	589	2116	Trajectory	1373	8202						
Production	1643	8197	Tuning	792	4376						
Productivity	457	2183	Uncertainty	6096	32244						
Protein	1688	8799	Vibration	761	4247						
Reaction	1393	6738									
Redundancy	606	3094									
Regression model	711	2341									
Regulation	1281	7903									
Resilience	512	2648									
Resistance	1189	5631									
Risk	1697	7050									

Robustness check	527	1262									
Sensitivity analysis	1549	6507									
Soil	383	1876									
Species	1973	10292									
Spectroscopy	895	4012									
Strain	945	5135									
Stress	890	4453									
Substrate	807	3343									
Survival	424	2345									
Testing	1427	6471									
Time series	651	2368									
Topology	1214	6022									
Transport	838	3646									
Utility	830	3778									
Variability	1893	8829									
Vulnerability	467	2305									
World	709	3130									
Yeast	257	1677									

Table 24 Cluster and term specification Robustness

Search term: Disaster resilience 1990-2017

WoS Categories excluded from search

Neurosciences	Psychiatry	Psychology Clinical	Medicine General Internal	Optics
Psychology Educational	Pediatrics	Family Studies	Education/ Educational Research	Psychology Developmental
Gerontology	Clinical Neurology	Nursing	Ergonomics	

Table 25 WoS categories excluded from search term Disaster Resilience

Evolution Timeline

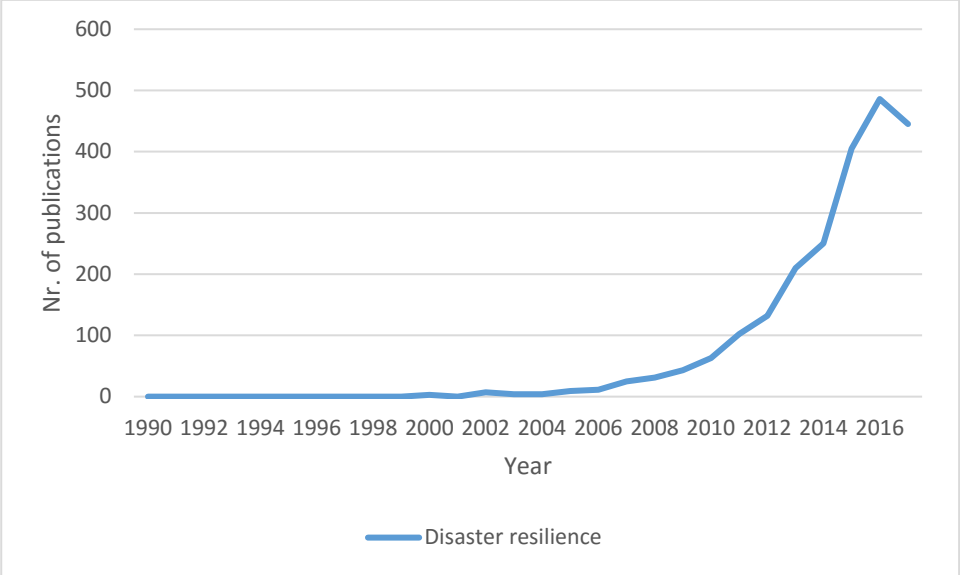

Fig. 36 Evolution of research in the context of Disaster Resilience

Top 10 Research Areas

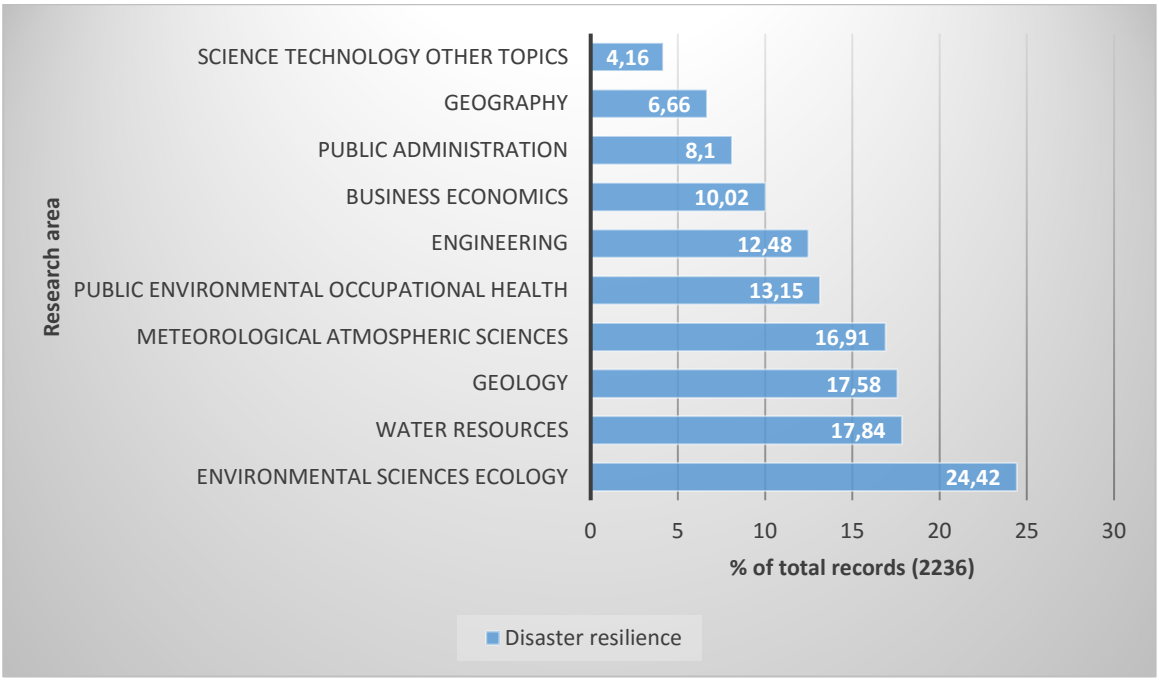

Fig. 37 Top 10 Research Areas in the context of Disaster Resilience

Network visualization

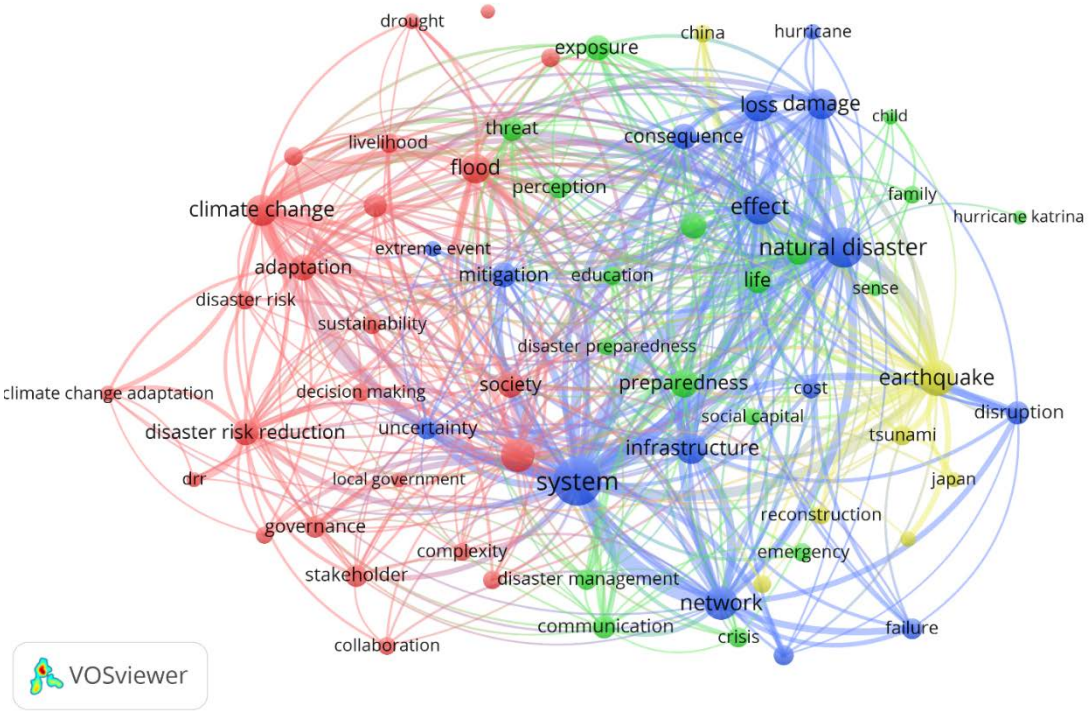

Fig. 38 Network visualization Disaster Resilience

Cluster and Term specification

Cluster 1			**Cluster 2**			**Cluster 3**			**Cluster 4**		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Adaptation	171	813	Child	58	256	Consequence	165	701	China	84	338
Adaptive capacity	91	433	Communication	135	600	Cost	99	415	Disaster recovery	85	322
Australia	89	377	Crisis	108	393	Damage	239	1034	Earthquake	322	1274
Climate change	252	1203	Disaster management	113	492	Disruption	137	553	Japan	59	264
Climate change adaptation	62	336	Disaster preparedness	74	330	Effect	330	1418	New Zealand	66	254
Collaboration	83	328	Education	90	392	Extreme event	63	348	Reconstruction	88	358
Complexity	86	417	Emergency	90	350	Failure	113	453	Tsunami	108	444
Decision making	83	387	Exposure	163	666	Hurricane	64	272			
Disaster risk	91	420	Family	82	350	Infrastructure	243	1076			
Disaster risk reduction	180	861	Health	160	720	Loss	251	1141			
Drought	62	343	Hurricane Katrina	51	176	Mitigation	152	738			
DRR	60	340	Intervention	173	662	Natural disaster	410	1683			
Flood	232	1078	Life	165	770	Network	290	1203			

Governance	119	530	Perception	114	482	Performance	103	442			
Integration	77	412	Preparedness	211	874	System	599	2392			
Livelihood	95	457	Sense	65	248	Uncertainty	118	571			
Local government	55	270	Social capital	78	317						
Natural hazard	134	643	Threat	144	618						
Practice	291	1118									
Social vulnerability	52	197									
Society	171	786									
Stakeholder	132	562									
Sustainability	100	448									
Water	87	369									

Table 26 Cluster and term specification Disaster Resilience

Search term: Community resilience 1990-2017

WoS Categories excluded from search

Nursing	Education Scientific Disciplines	Pharmacology/ Pharmacy	Biochemistry/ Molecular Biology	Language/ Linguistics
Neurosciences	Information Science/ Library Science	Clinical Neurology	Respiratory System	Ornithology
Entomology	Medicine General Internal	Psychology Developmental	Parasitology	Dentistry Oral Surgery Medicine
Geriatrics/ Gerontology	Psychology Educational	Education/ Educational Research	Biochemical Research Methods	Onstetrics Gynecology
Evolutionary Biology	Zoology	Immunology	Mycology	
Genetics Hereditary	Psychology Clinical	Substance Abuse	Education Special	
Psychiatry	Family Studies	Paleontology	Endocrinology Metabolism	
Operations Research Management Science	Pediatrics	Sport Sciences		

Table 27 WoS categories excluded from search term Community Resilience

Evolution Timeline

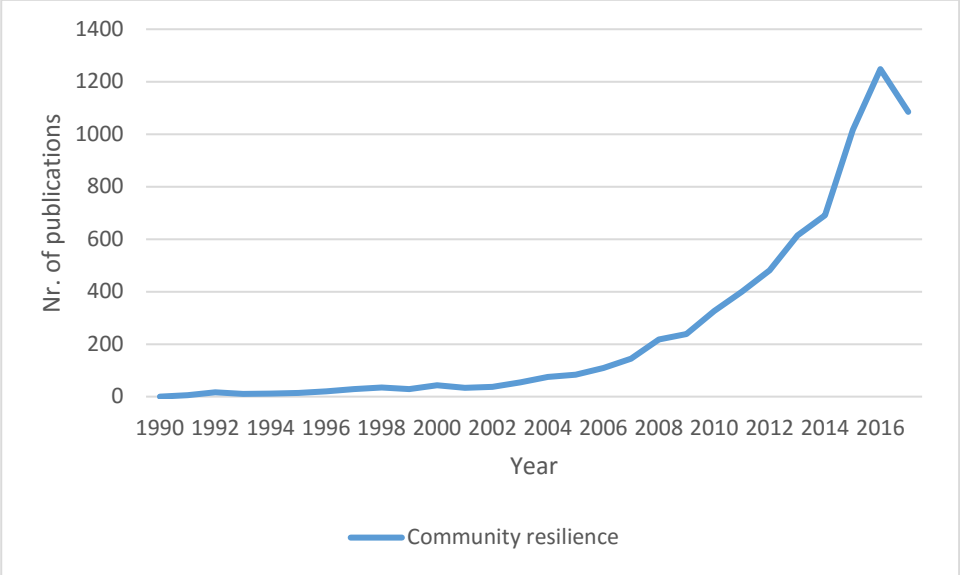

Fig. 39 Evolution of research in the context of Community Resilience

Top 10 Research Areas

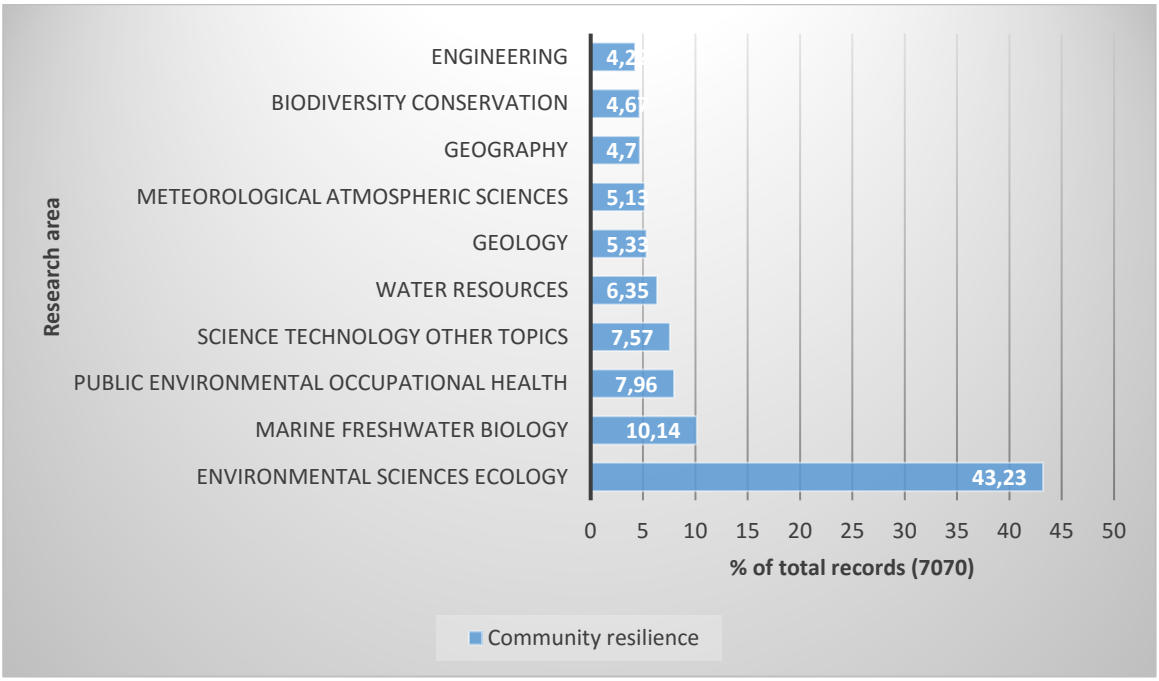

Fig. 40 Top 10 Research Areas in the context of Community Resilience

Network visualization

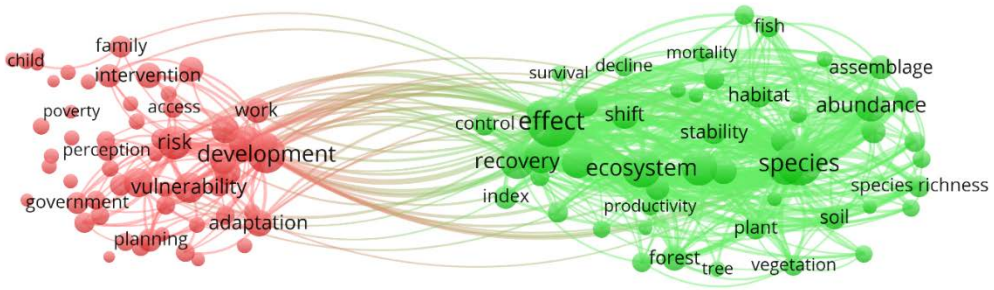

Fig. 41 Network visualization Community Resilience

Cluster and Term specification

Cluster 1			Cluster 2		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Access	300	1881	Abundance	761	5582
Action	505	3065	Assemblage	414	3124
Adaptation	535	3224	Biodiversity	387	2946
Adaptive capacity	252	1623	Biomass	430	3258
Awareness	161	1017	Community composition	306	2336
Building	252	1463	Community structure	395	2832
Child	200	944	Control	369	2444
City	320	1740	Coral reef	286	2006
Climate change adaptation	106	705	Decline	313	2240
Coastal community	149	913	Degradation	254	1918
Communication	167	944	Density	451	3372
Community resilience	490	2543	Distribution	398	2701
Conflict	179	954	Disturbance	924	6728
Crisis	183	881	Diversity	909	6598
Culture	186	913	Drought	302	2232
Decision	259	1575	Dynamic	702	4571
Decision making	164	1050	Ecosystem	1127	8060

Development	1061	6027	Ecosystem function	161	1330
Disaster resilience	129	582	Ecosystem resilience	138	1086
Earthquake	200	1099	Effect	1853	11990
Education	208	1106	Environmental condition	156	1107
Effectiveness	207	1210	Fire	273	2041
Family	352	1842	Fish	317	2284
Governance	248	1427	Forest	473	3582
Government	339	1963	Growth	395	2619
Hazard	311	1932	Habitat	482	3660
Health	443	2447	Index	386	2525
Home	120	671	Microbial community	241	1504
Household	245	1448	Mortality	224	1710
Infrastructure	241	1403	Organism	196	1410
Integration	196	1161	Persistence	183	1268
Intervention	465	2482	Perturbation	233	1637
Life	396	2025	Plant	343	2567
Livelihood	262	1745	Plant community	218	1814
Local community	183	1088	Productivity	220	1662
Mental health	130	590	Recovery	878	5830
Natural disaster	170	924	Resistance	506	3582
Network	564	3054	Restoration	219	1521
Perception	293	1520	Shift	541	3736
Planning	398	2495	Soil	425	2989
Policy	624	3594	Species	1483	10605
Poverty	145	870	Species composition	228	1895
Resource	885	5290	Species diversity	139	1225
Risk	807	4739	Species richness	350	2996
Rural community	152	796	Stability	421	2836
School	153	740	Structure	882	5991
Sense	176	835	Survival	182	1240
Social capital	169	1000	Temperature	309	2010
Social ecological system	168	931	Tree	178	1409
Society	307	1715	Vegetation	313	2394
Stakeholder	236	1365			
Sustainability	306	1656			
Uncertainty	195	1200			
Vulnerability	676	4007			
Woman	174	795			
Work	439	2367			
Youth	157	681			

Table 28 Cluster and term specification Community Resilience

Search term: Urban resilience 1990-2017

WoS Categories excluded from search

Pediatrics	Neurosciences	Education/ Educational Research	Zoology	Psychology Educational
Medicine General Internal	Nursing	Substance Abuse	Family Studies	Obstetrics Gynecology
Gerontology	Plant Sciences	Psychiatry	Psychology Clinical	

Table 29 WoS categories excluded from search term Urban Resilience

Evolution Timeline

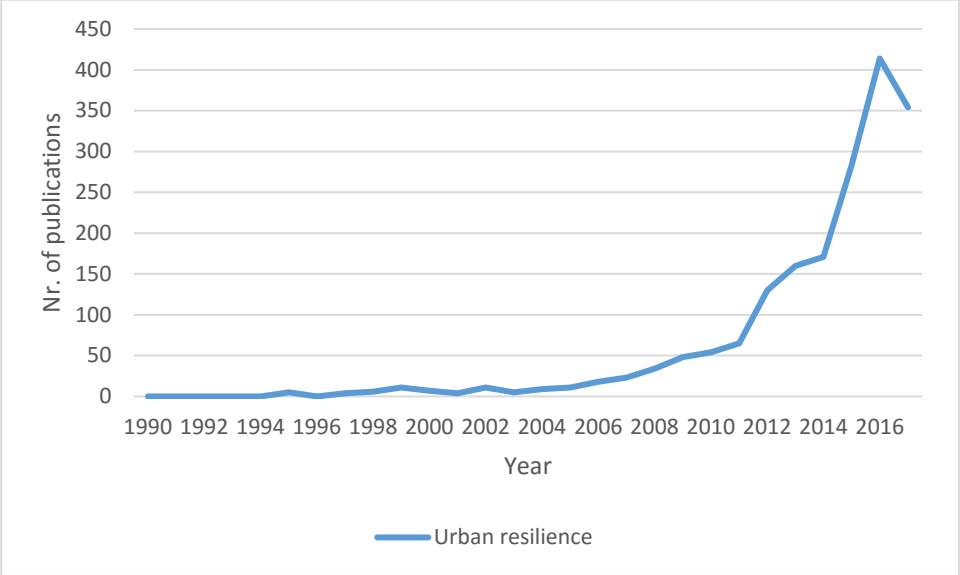

Fig. 42 Evolution of research in the context of Urban Resilience

Top 10 Research Areas

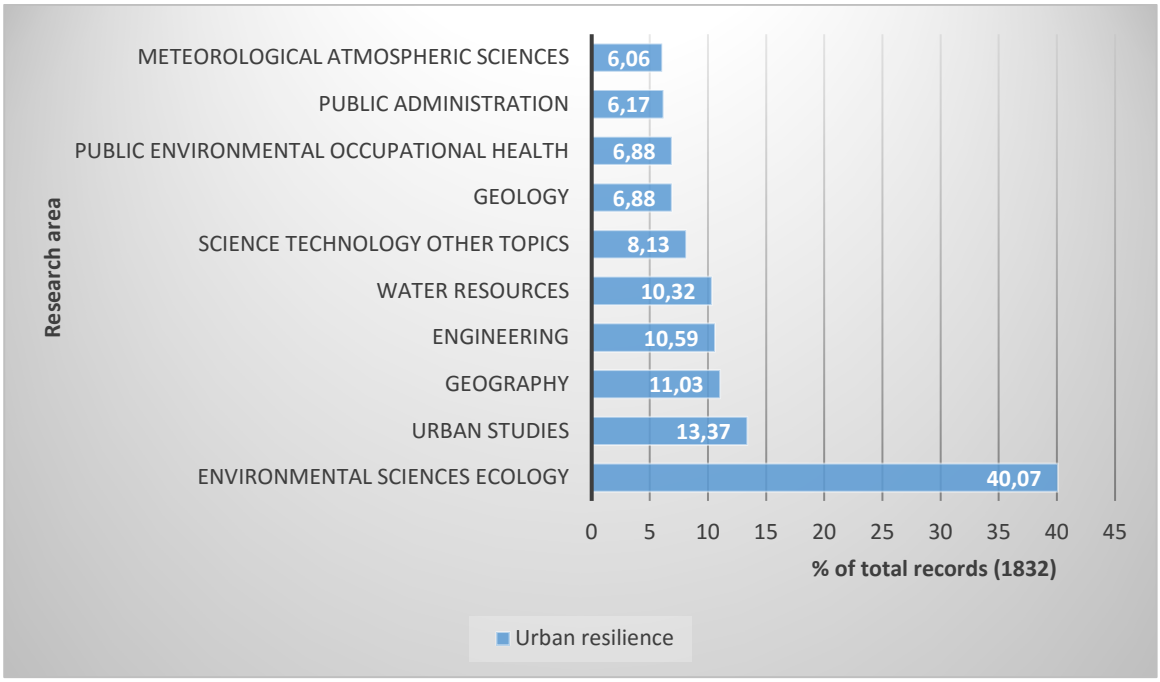

Fig. 43 Top 10 Research Areas in the context of Urban Resilience

Network visualization

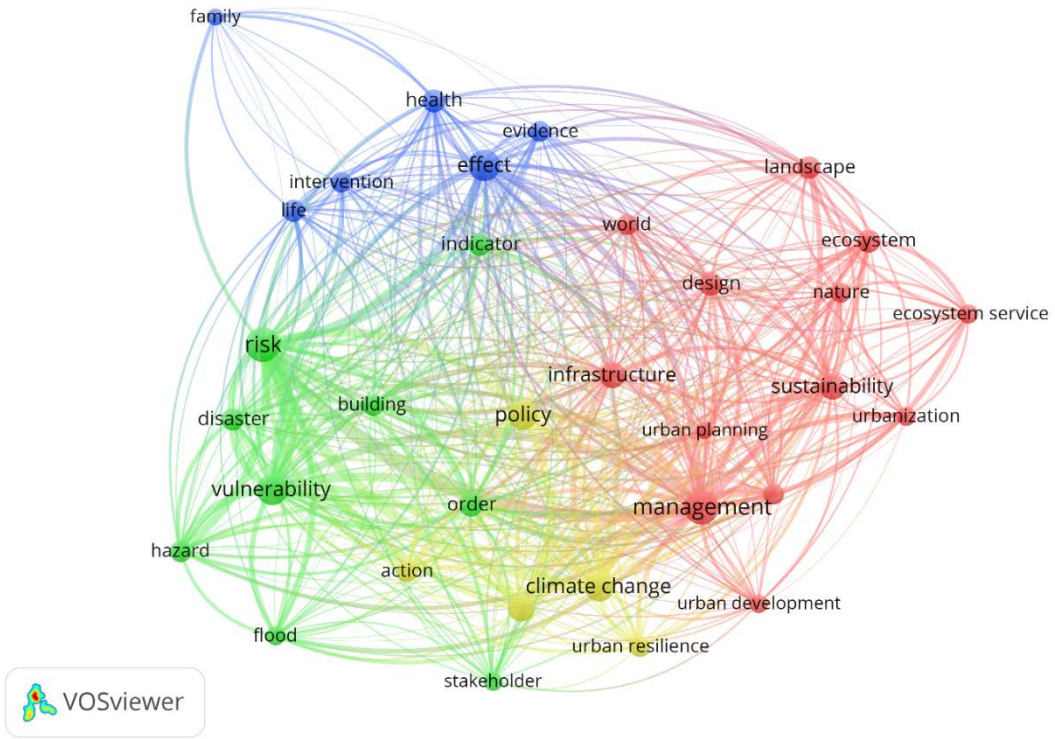

Fig. 44 Network visualization Urban Resilience

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Design	127	437	Building	103	424	Effect	235	672	Action	107	455
Ecosystem	122	425	Disaster	116	457	Evidence	94	304	Adaptation	167	701
Ecosystem service	80	306	Flood	81	367	Family	63	135	Climate change	208	902
Infrastructure	160	562	Hazard	101	453	Health	123	394	Policy	216	713
Landscape	110	366	Indicator	110	343	Intervention	97	298	Urban resilience	95	355
Management	297	1027	Order	135	503	Life	109	327			
Nature	88	317	Risk	292	1095						
Sustainability	159	514	Stakeholder	78	295						
Urban development	72	271	Vulnerability	227	863						
Urban planning	65	289									
Urbanization	79	299									
Water	99	354									
World	99	361									

Table 30 Cluster and term specification Urban Resilience

Search term: (Economic) Development resilience 1990-2017

WoS Categories excluded from search

~~Endocrinology Metabolism~~	~~Pediatrics~~	~~Neurosciences~~	~~Substance Abuse~~	~~Oncology~~
~~Genetics Heredity~~	~~Psychology/ Psychology Multidisciplinary~~	~~Evolutionary Biology~~	~~Immunology~~	~~Surgery~~
~~Psychiatry~~	~~Social Work~~	~~Family Studies~~	~~Nursing~~	~~Psychology Educational~~
~~Psychology Developmental~~	~~Sport Sciences~~	~~Medicine Research Experimental~~	~~Education Scientific Disciplines~~	~~Zoology~~
~~Clinical Neurology~~	~~Pharmacology/ Pharmacy~~	~~Psychology Clinical~~	~~Information Science/ Library Science~~	~~Optics~~
~~Geriatrics/ Gerontology~~	~~Education/ Educational Research~~	~~Education Special~~	~~Psychology Applied~~	~~Paleontology~~

Table 31 WoS categories excluded from search term (Economic) Development Resilience

Evolution Timeline

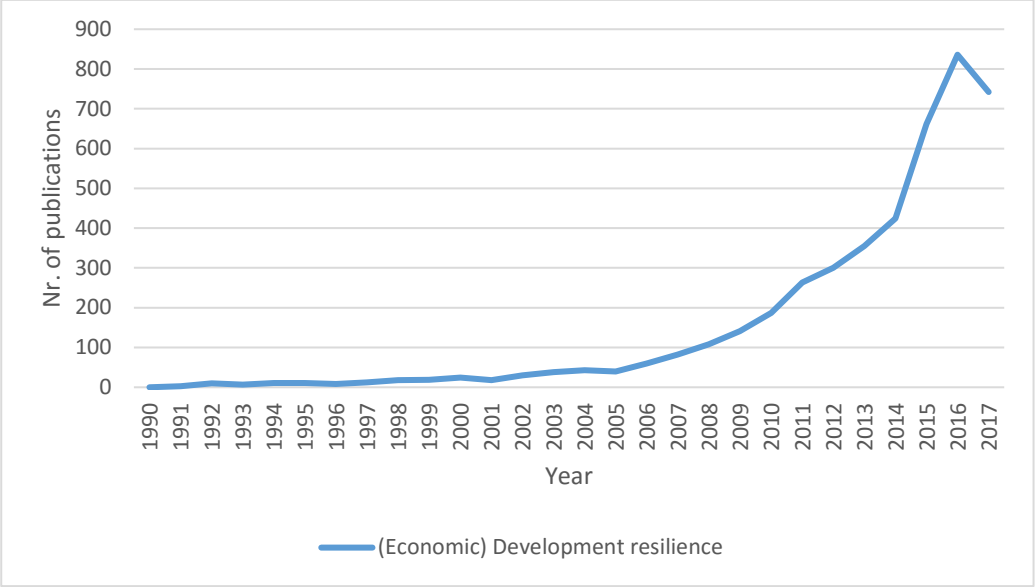

Fig. 45 Evolution of research in the context of (economic) Development Resilience

Top 10 Research Areas

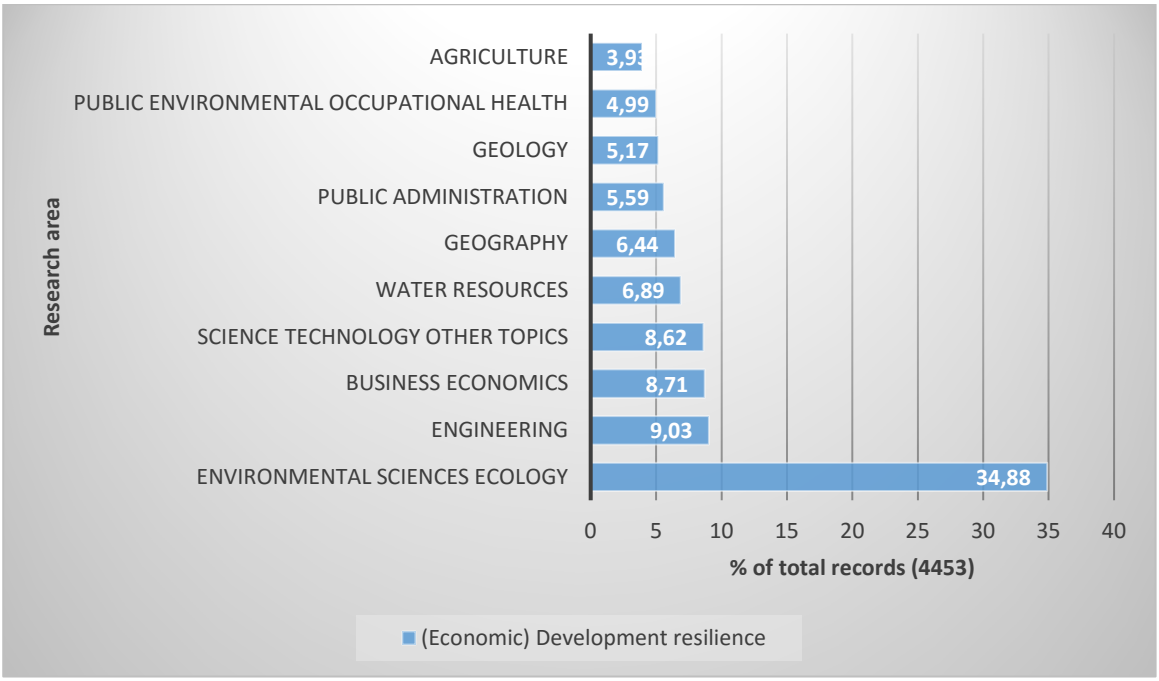

Fig. 46 Top 10 Research Areas in the context of (economic) Development Resilience

Network visualization

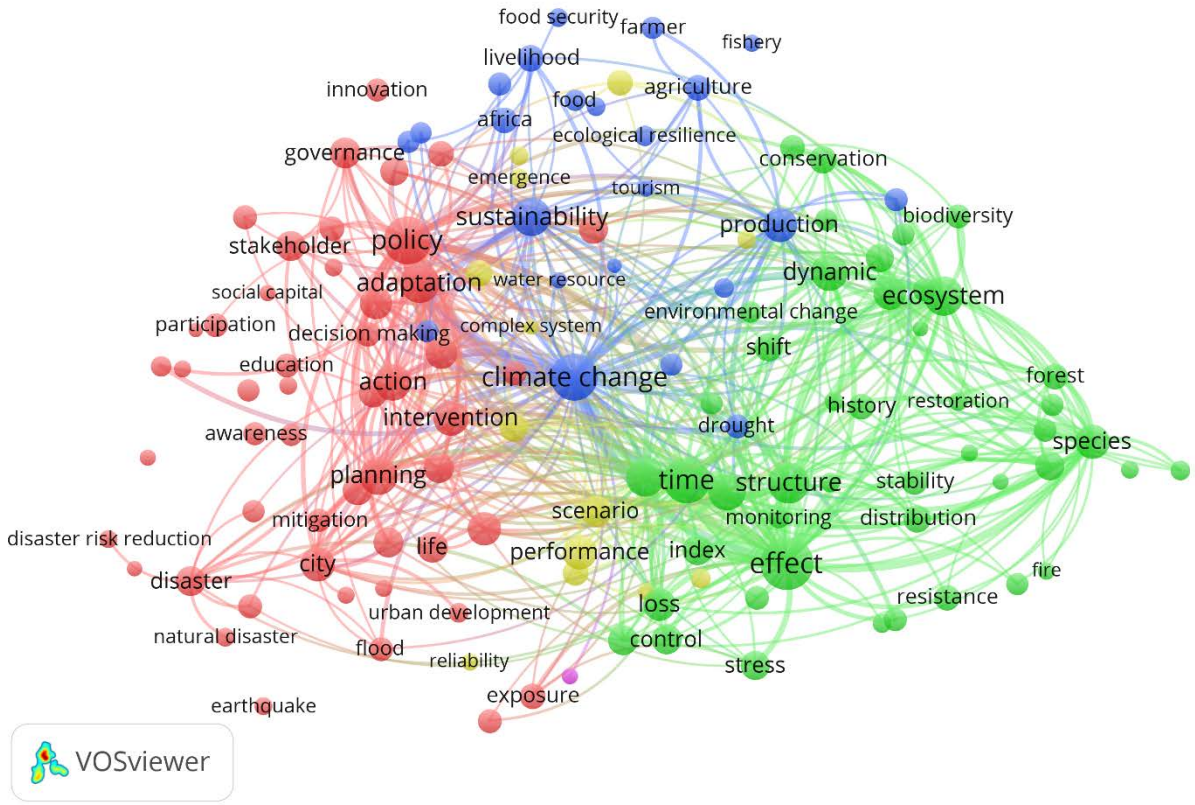

Fig. 47 Network visualization (economic) Development Resilience

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**	**Term**	**Occ**	**Link str**
Action	390	2606	Abundance	99	690	Africa	172	1199	Adaptability	92	612
Adaptation	460	3115	Biodiversity	157	1328	Agriculture	180	1406	Behavior	183	889
Adaptive capacity	168	1199	Connectivity	94	686	Climate change	681	4922	Complex system	56	368
Awareness	137	911	Conservation	209	1598	Climate variability	53	442	Complexity	56	368
Building	243	1584	Control	250	1341	Drought	154	1220	Emergence	94	584
Business	86	497	Decline	133	881	Ecological resilience	105	731	Feedback	91	674
City	334	2168	Degradation	141	1089	Energy	131	831	Performance	325	1532
Climate change adaptation	111	820	Distribution	204	1287	Farmer	125	904	Reliability	76	360
Communication	126	772	Disturbance	235	1666	Fishery	73	520	Robustness	71	356
Community resilience	133	839	Diversity	294	2084	Food	117	874	Scenario	267	1916
Crisis	212	1126	Dynamic	389	2580	Food security	88	721	Simulation	99	569

Culture	149	761	Ecology	127	881	Household	128	894	Social ecological system	172	1217
Damage	149	1002	Ecosystem	449	3373	Land use	100	798	Uncertainty	234	1611
Decision	247	1721	Ecosystem service	160	1312	Livelihood	193	1487			
Decision making	167	1261	Effect	864	4888	Market	143	783			
Disaster	253	1625	Environmental change	117	837	Natural resource	89	667			
Disaster risk reduction	81	583	Environmental condition	68	484	Poverty	116	829			
Earthquake	84	525	Fire	75	586	Production	339	2227			
Education	148	816	Flow	128	798	Productivity	139	1047			
Exposure	178	1042	Forest	182	1362	Security	128	784			
Flood	148	1115	Growth	402	2519	Sustainability	434	2722			
Governance	262	1824	Habitat	125	980	Tourism	69	409			
Hazard	157	1184	History	184	1164	Water resource	66	514			
Health	312	1713	Human activity	56	428						
Infrastructure	251	1613	Index	247	1416						
Innovation	137	862	Landscape	214	1646	* Sea level rise	63	505			
Integration	219	1397	Loss	307	2073						
Intervention	355	1954	Maintenance	99	634						
Learning	154	993	Material	157	871						
Life	261	1311	Monitoring	124	751						
Local government	63	462	Persistence	73	546						
Local level	54	360	Plant	130	863						
Mitigation	137	1050	Population	436	2929						
Natural disaster	94	635	Recovery	242	1538						
Natural hazard	56	394	Resistance	180	1057						
Participation	148	935	Restoration	89	642						
Planning	410	2824	Shift	222	1525						
Policy	686	381	Soil	138	954						
Resiliency	71	381	Species	340	2420						
Responsibility	77	440	Stability	177	1023						
Science	237	1546	Stress	237	1211						
Sense	86	451	Structure	501	3037						
Skill*	125	605	Survival	89	558						
Social capital	69	420	Temperature	139	893						
Society	290	1831	Time	649	3730						
Stakeholder	247	1630	Vegetation	86	649						
Sustainable development	275	1791									
Transformation	179	1189									
Urban area	75	518									
Urban development	96	708									

Table 32 Cluster and term specification (economic) Development Resilience

* Only in the context of (economic) Development Resilience does the term *'skill'* occur with some significance.

2.5 Detailed Group 3 Search Terms for co-occurrence network of terms analysis

Search term: Planetary Boundaries 2009-2017

WoS Categories excluded from search

None

Evolution Timeline

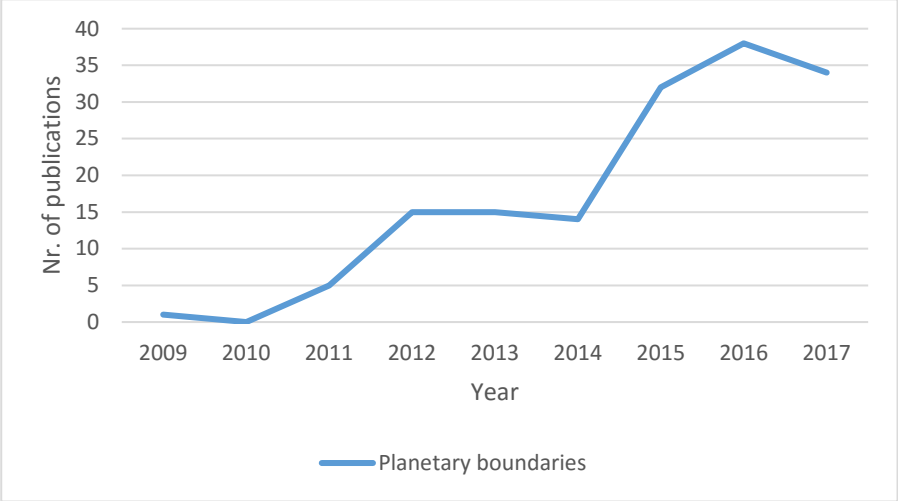

Fig. 48 Evolution of research in the context of Planetary Boundaries

Top 10 Research Areas

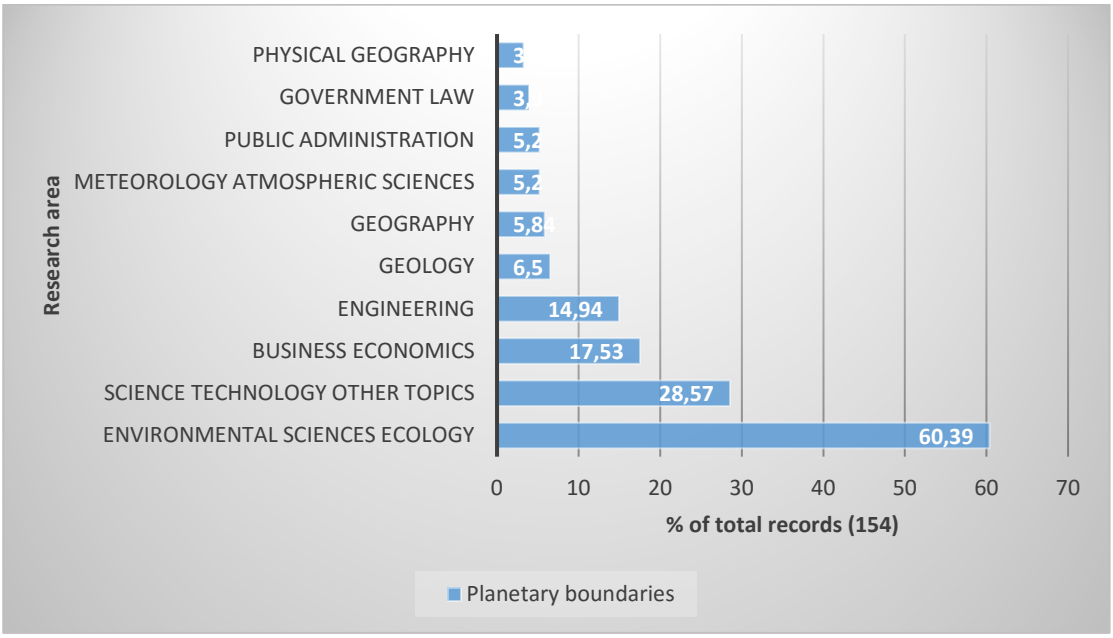

Fig. 49 Top 10 Research Areas in the context of Planetary Boundaries

Network visualization

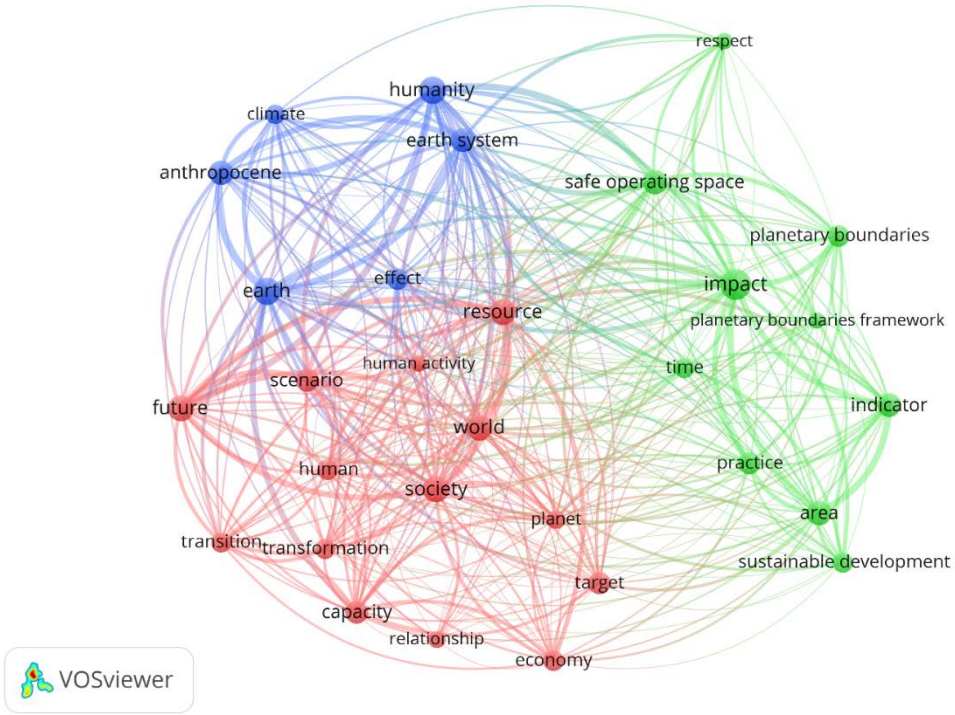

Fig. 50 Network visualization Planetary Boundaries

Cluster and Term specification

Cluster 1			**Cluster 2**			**Cluster 3**		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**		**Link strength**
Capacity	19	75	Area	22	71	Anthropocene	22	79
Economy	16	61	Impact	35	125	Climate	14	62
Future	24	103	Indicator	20	69	Earth	27	116
Human	16	73	Planetary boundaries	17	54	Earth system	20	98
Human activity	10	41	Planetary boundaries framework	10	39	Effect	17	53
Planet	13	67	Practice	18	62	Humanity	27	109
Relationship	11	27	Respect	10	42			
Resource	24	101	Safe operating space	22	86			
Scenario	19	83	Sustainable development	15	45			
Society	26	107	Time	15	50			
Target	18	59						
Transformation	15	55						
Transition	15	67						
World	24	95						

Table 33 Cluster and term specification Planetary Boundaries

Search terms: Natural Capital and Ecoservices 1990-2017

WoS Categories excluded from search

Information Science/ Library Science	Surgery	Entomology	Tropical Medicine	Pediatrics
Psychiatry	Parasitology	Substance Abuse	Mechanics	Orthopedics

Table 34 WoS categories excluded from search terms Natural Capital and Ecoservices

Evolution Timeline

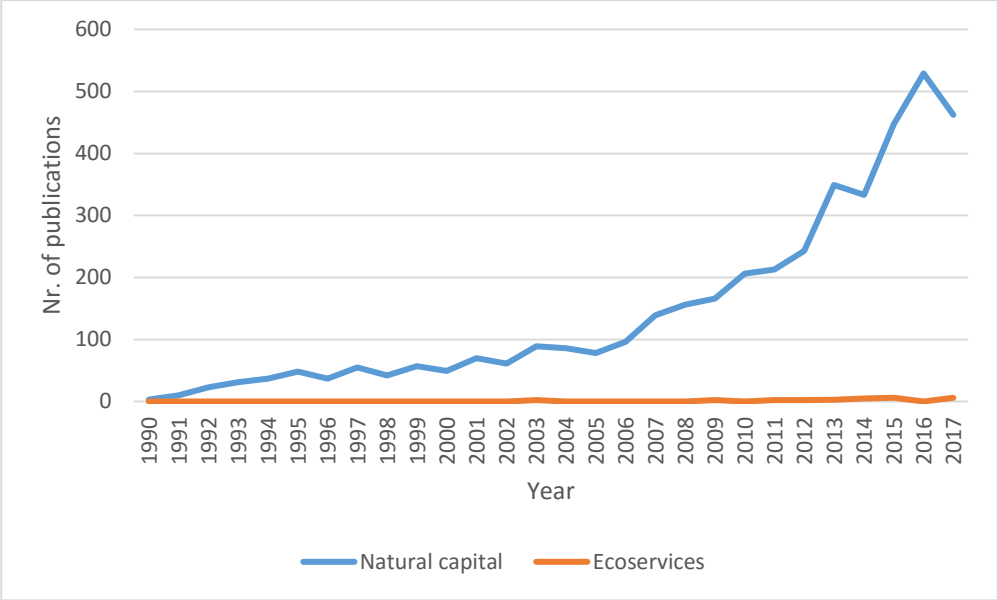

Fig. 51 Evolution of research in the context of Natural Capital and Ecoservices

Top 10 Research Areas

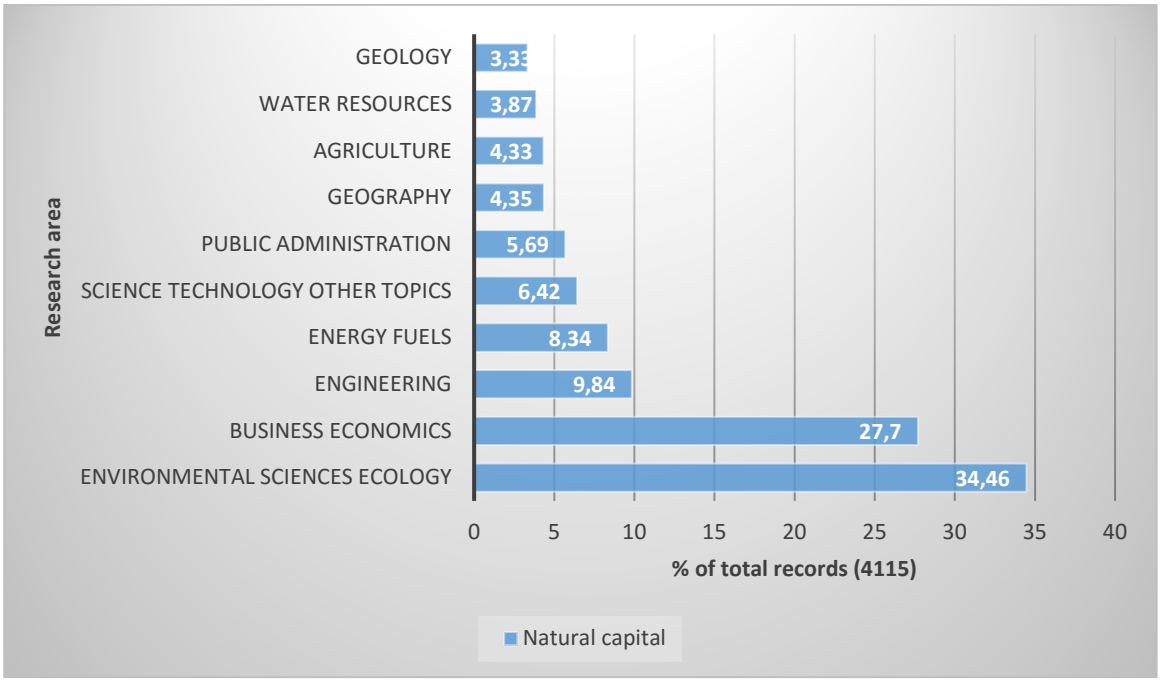

Fig. 52 Top 10 Research Areas in the context of Natural capital

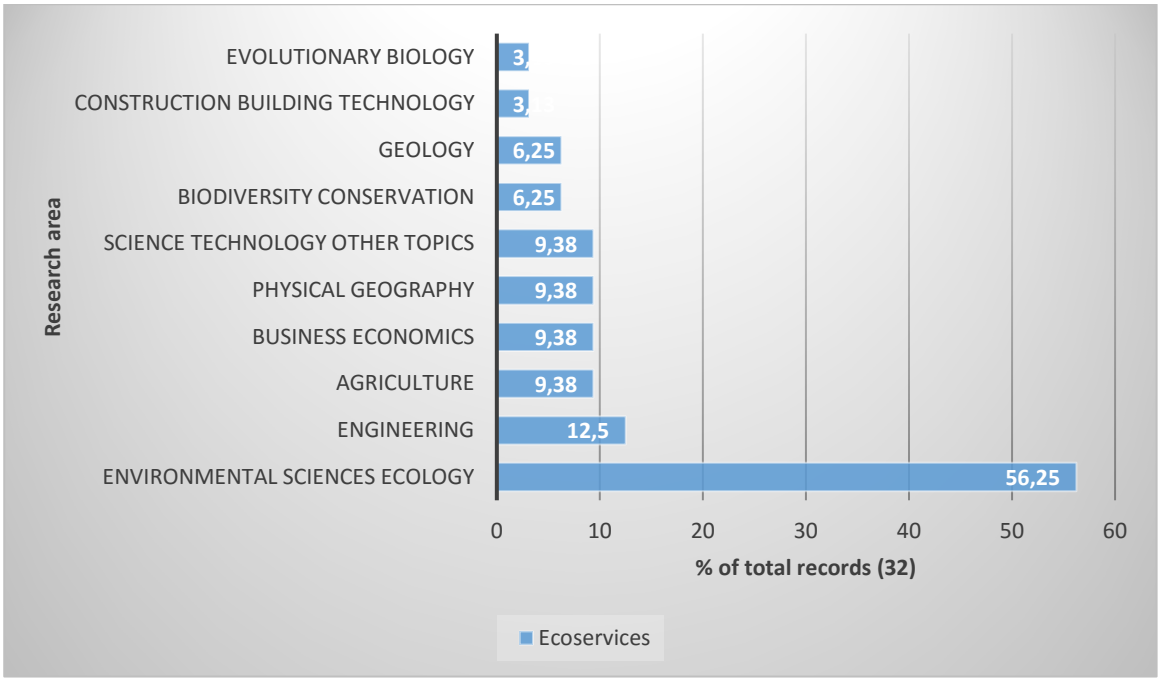

Fig. 53 Top 10 Research areas in the context of Ecoservices

Network visualization

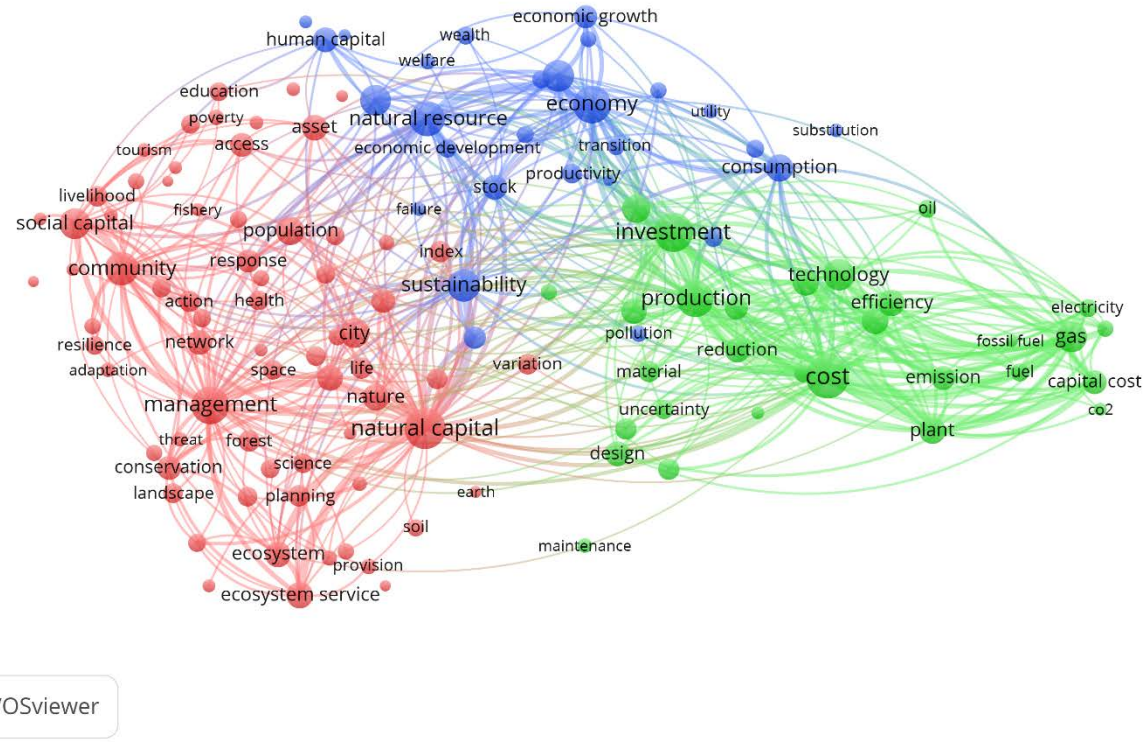

Fig. 54 Network visualization in the context of Natural Capital and Ecoservices

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Access	238	1695	Alternative	138	897	Consumption	311	2214
Action	191	1373	Capital cost	239	1639	Depletion	110	834
Adaptation	95	742	CO2	71	605	Economic development	156	1125
Agriculture	157	1351	Coal	119	1050	Economic growth	222	1550
Asset	276	1894	Cost	751	4884	Economy	579	3770
Biodiversity	138	1155	Design	259	1679	Employment	76	471
Building	142	903	Efficiency	300	2275	Evidence	399	2063
City	366	1952	Electricity	134	1139	Failure	84	559
Climate change	166	1349	Emission	241	2034	Growth	422	2691
Community	473	3366	Energy	287	2337	Human capital	259	1699
Complexity	93	698	Environmental impact	74	672	Input	156	1139
Conflict	125	879	Fossil fuel	60	592	Labor	117	754
Conservation	247	2003	Gas	389	2702	Long term	54	430

Decision making	111	792	Industry	327	2122	Nation	126	923
Degradation	173	1375	Investment	654	4110	Natural resource	518	3417
Diversity	119	921	Maintenance	90	630	Output	140	936
Earth	62	552	Material	190	1367	Physical capital	65	508
Earthquake	74	352	Oil	140	978	Pollution	116	836
Ecosystem	274	2177	Performance	289	1800	Productivity	158	1159
Ecosystem service	291	2202	Plant	304	2232	Stock	266	1641
Education	156	1055	Power	222	1563	Substitution	77	506
Emergence	65	403	Product	283	2044	Sustainability	434	3085
Exposure	78	378	Production	574	4179	Sustainable development	216	1523
Farmer	109	883	Recovery	115	858	Trade	139	919
Fishery	69	493	Reduction	257	1944	Transition	126	932
Food	71	624	Scenario	188	1423	Utility	89	570
Forest	188	1440	Solution	201	1410	Wealth	141	935
Governance	149	1055	Technology	420	3127	Welfare	105	706
Health	167	1202	Uncertainty	149	1001			
History	152	848						
Human activity	55	436						
Index	192	1168						
Intervention	133	904						
Land	284	2157						
Land use	106	865						
Landscape	160	1234						
Life	198	1253						
Livelihood	176	1474						
Local community	54	430						
Management	596	4032						
Migration	77	448						
Natural capital	693	4852						
Natural disaster	153	873						
Natural resource management	76	560						
Nature	302	2006						
Network	258	1642						
Perception	112	798						
Planning	190	1467						
Poverty	97	742						
Protection	150	1126						
Provision	103	818						
Resilience	155	1190						
Response	233	1488						
Restoration	76	592						
Rural area	58	433						
Science	162	1030						
Social capital	400	2568						
Society	246	1804						
Soil	123	889						
Space	164	1035						
Species	167	1144						
Threat	90	646						

Tourism	78	514						
Transformation	101	742						
Trust	76	480						
Urban area	71	427						
Variation	179	963						
Village	79	584						
Vulnerability	119	855						

Table 35 Cluster and term specification Natural Capital and Ecoservices

Search term: Circular Economy 1990-2017

WoS Categories excluded from search

None

Evolution Timeline

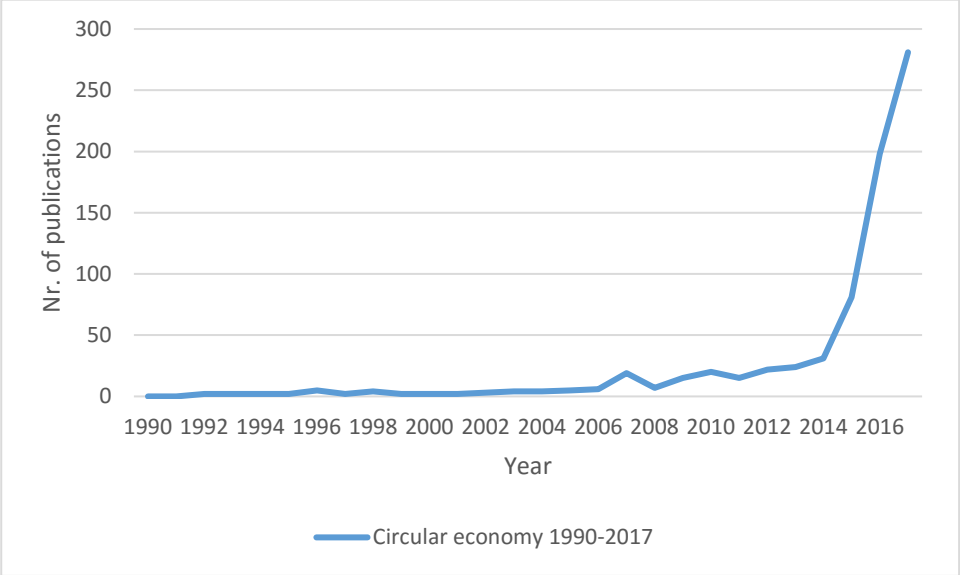

Fig. 55 Evolution of research in the context of Circular Economy

Top 10 Research Areas

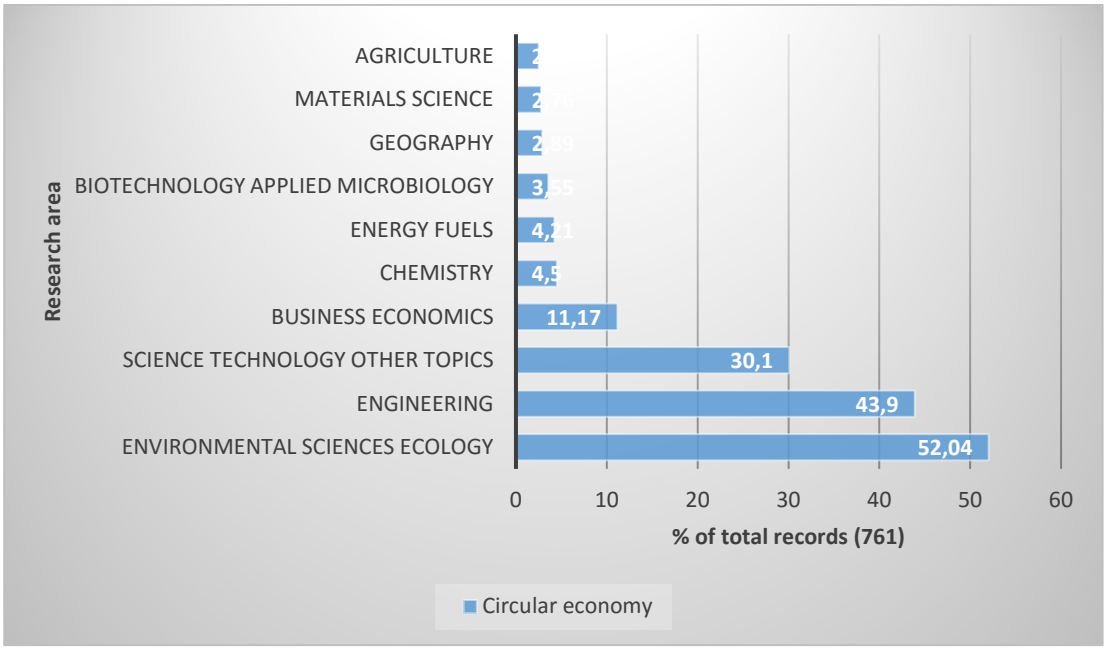

Fig. 56 Top 10 Research Areas in the context of Circular Economy

Network visualization

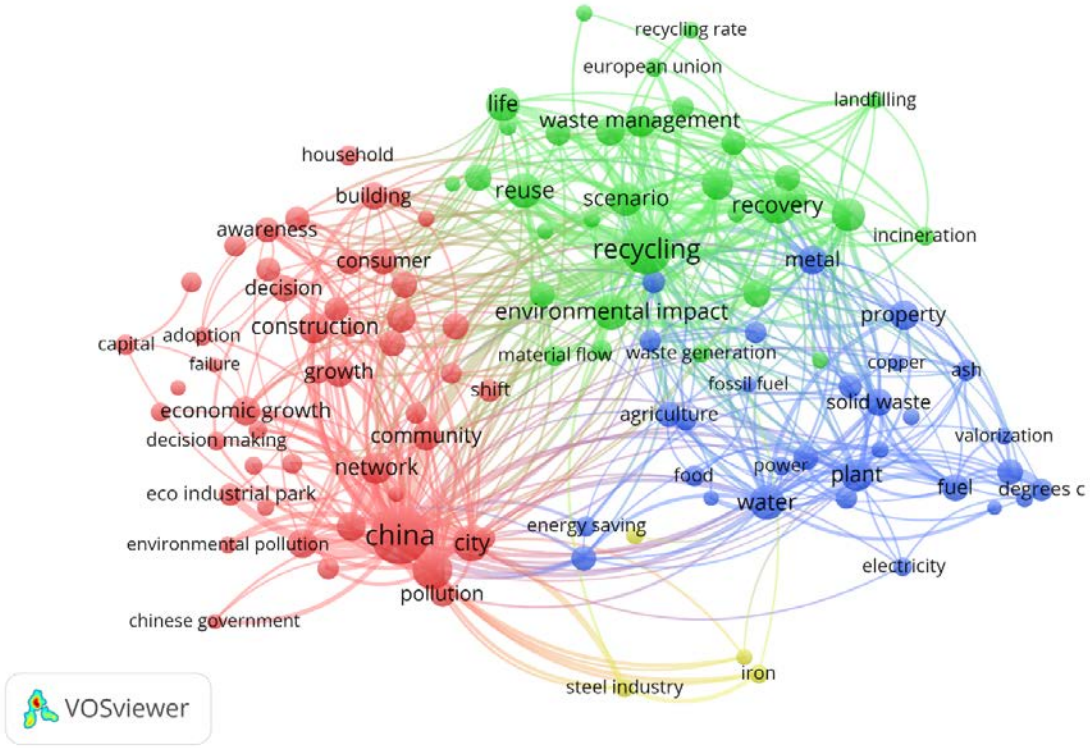

Fig. 57 Network visualization Circular Economy

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Adoption	16	69	Alternative	33	166	Agriculture	25	114
Awareness	27	109	Disposal	26	169	Ash	19	107
Behavior	25	73	Energy recovery	12	60	Biogas	10	51
Building	33	144	Environmental impact	57	286	Biomass	21	91
Business model	26	118	Europe	28	114	Cement	13	78
Capital	18	55	European Union	16	81	Chemical	28	119
China	149	625	Export	13	78	Climate change	23	125
Chinese government	11	55	Greenhouse gas emission	12	77	CO2	13	68
Circular flow	21	38	Incineration	15	96	Copper	11	67
City	58	278	Landfilling	13	96	Degrees c	22	85
Community	36	138	Legislation	21	72	Electricity	16	81
Conflict	13	56	Life	48	185	Energy consumption	27	152
Construction	43	195	Life cycle assessment	42	226	Energy saving	18	90
Consumer	33	117	Long term	11	51	Food	20	96
Decision	30	105	Loop	36	158	Fossil fuel	11	66
Decision making	16	72	Loss	31	112	Fuel	32	173
Dynamic	31	123	Material flow	20	105	Heat	13	85
Eco efficiency	15	87	Material flow analysis	18	101	Influence	21	80
Eco industrial park	22	103	Material loop	12	59	Limit	21	78
Economic activity	16	53	Netherlands	12	38	Metal	37	183
Economic development	38	163	Plastic	21	86	Optimization	21	111
Economic growth	36	155	Processing	29	138	Plant	45	220
Education	12	48	Raw material	50	242	Power	16	78
Effectiveness	18	88	Recovery	59	277	Property	38	158
Employment	11	28	Recycling	110	550	Residue	24	107
Environmental performance	20	97	Recycling rate	13	82	Soil	11	62
Environmental pollution	13	62	Resource recovery	13	63	Solid waste	32	200
Environmental protection	21	86	Reuse	53	243	Valorization	13	75
Evidence	29	114	Scenario	50	312	Water	54	262
Failure	10	28	Stock	28	163			
Germany	12	53	Waste generation	16	99			
Growth	38	168	Waste management	43	209			
Household	18	67						
Industrial ecology	14	64				*Coal	12	68

Industrial symbiosis	36	171				*Iron	15	77
Law	17	73				*Steel industry	16	92
Nature	36	117				*Wastewater	14	55
Network	44	158						
Political economy	18	39						
Pollution	29	168						
Progress	25	131						
Resource consumption	18	114						
Sustainable development	68	315						
Transformation	30	126						
Value chain	15	66						

Table 36 Cluster and term specification Circular Economy

Search term: Social Metabolism OR Urban Metabolism 1990-2017

WoS Categories excluded from search

Agriculture Dairy Animal Science	Pharmacology/ Pharmacy	Zoology	Dermatology	Pathology
Chemistry Medicinal	Biochemical Research Methods	Peripheral Vascular Disease	Marine Freshwater Biology	Evolutionary Biology
Neurosciences	Reproductive Biology	Hematology	Radiology Nuclear Medicine/ Medical Imaging	Psychology Developmental
Veterinary Sciences	Geriatrics/ Gerontology	Nutrition Dietetics	Respiratory System	Microbiology
Gastroenterology Hepatology	Neuroimaging	Surgery	Medicine Research Experimental	Rehabilitation
Oceanography	Obstetrics Gynecology	Infectious Diseases	Sport Sciences	Entomology
Psychiatry	Genetics Heredity	Medicine General Internal	Developmental Biology	Critical Care Medicine
Psychology Clinical	Plant Sciences	Clinical Neurology	Tropical Medicine	Substance Abuse
Oncology	Nursing	Cardiac Cardiovascular Systems	Biotechnology/ Applied Microbiology	Cell Biology
Endocrinology Metabolism	Toxicology	Physiology	Medicine Legal	Urology Nephrology
Psychology Biological	Immunology	Fisheries	Pediatrics	

Table 37WoS categories excluded from search term Social OR Urban Metabolism

Evolution Timeline

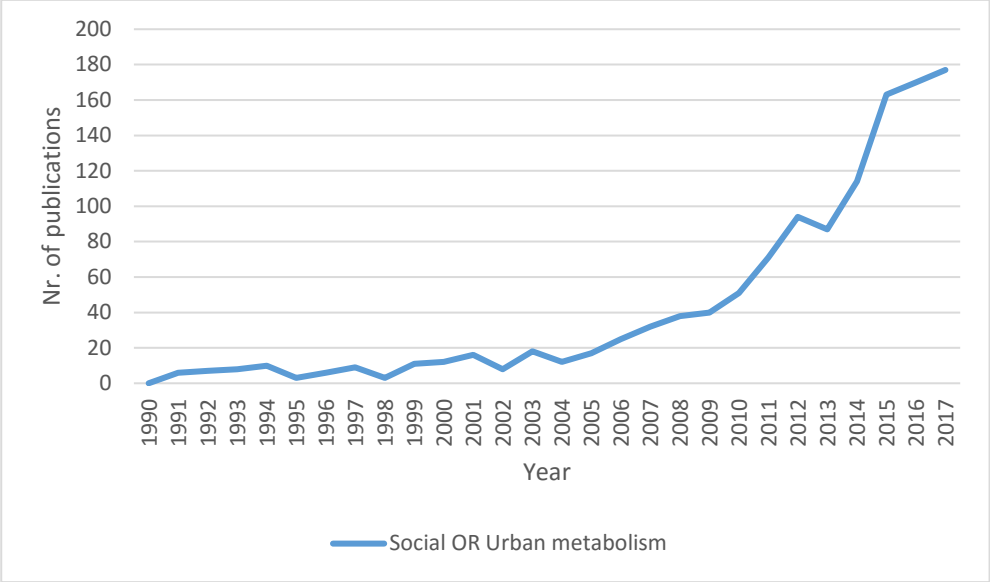

Fig. 58 Evolution of research in the context of Social OR Urban Metabolism

Top 10 Research Areas

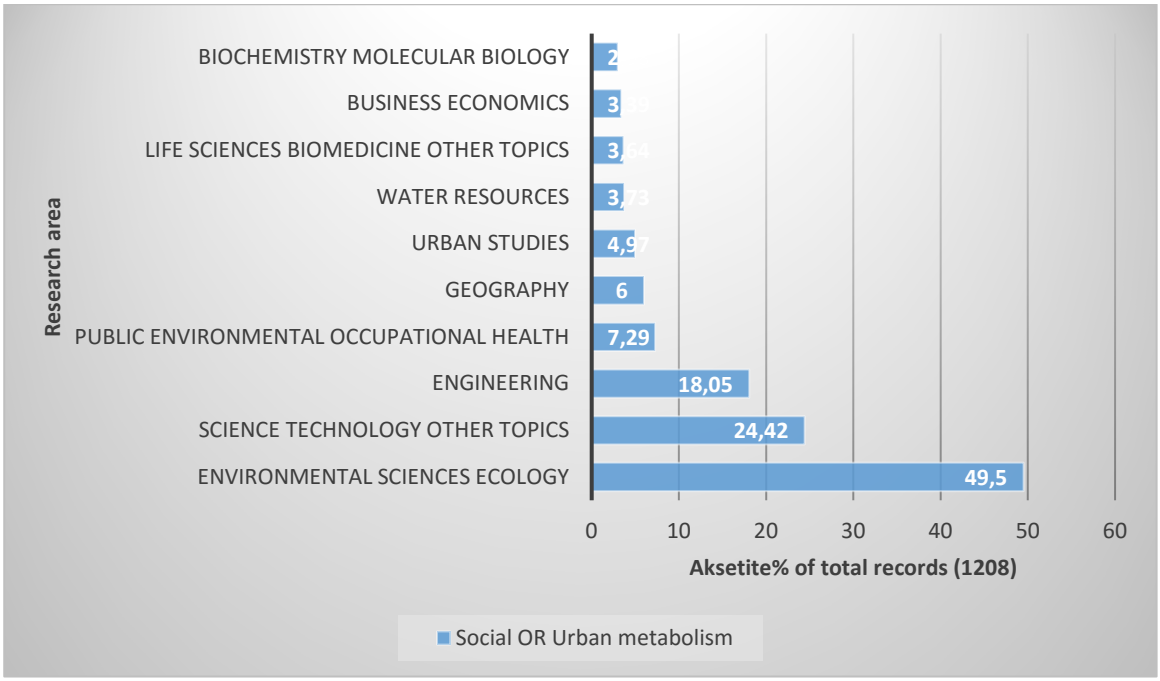

Fig. 59 Top 10 Research Areas in the context of Social OR Urban Metabolism

Network visualization

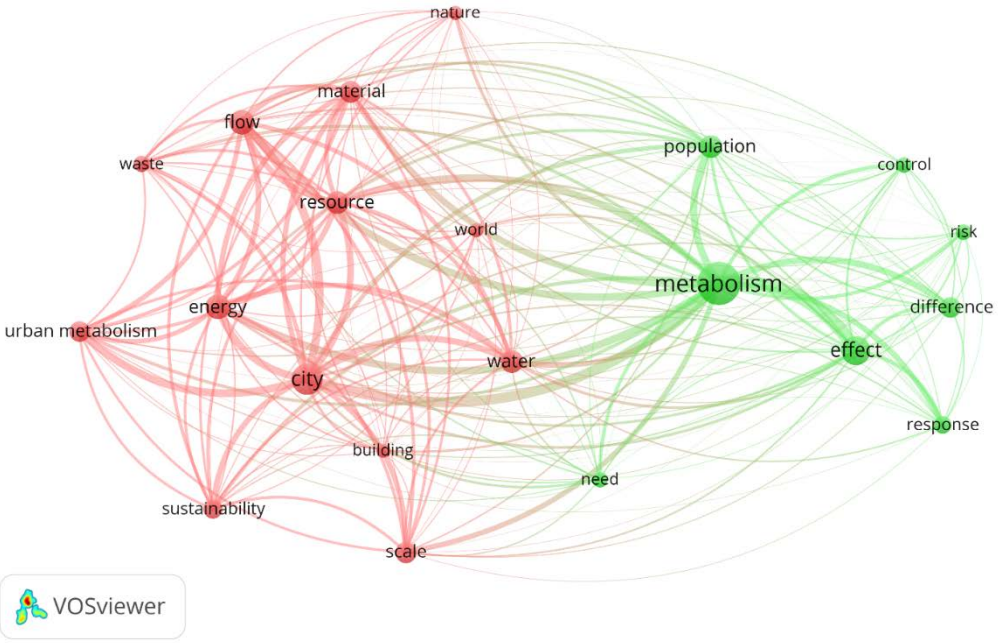

Fig. 60 Network visualization Social OR Urban Metabolism

Cluster and Term specification

Cluster 1			**Cluster 2**		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Building	68	251	Control	85	232
City	334	1139	Difference	148	331
Energy	214	822	Effect	287	652
Flow	216	851	Metabolism	635	1417
Material	166	698	Need	82	284
Nature	70	230	Population	179	523
Resource	181	764	Response	108	281
Scale	157	523	Risk	82	190
Sustainability	125	488			
Urban metabolism	145	576			
Waste	93	394			
Water	181	659			
World	68	251			

Table 38 Cluster and term specification Social OR Urban Metabolism

Search term: Inclusive wealth OR Inclusive economy OR Inclusive growth 1990-2017

WoS Categories excluded from search

Biochemistry/ Molecular Biology	Physics Nuclear	Cell Biology	Education Special	Gerontology
Information Science/ Library Science	Clinical Neurology	Mathematical Computational Biology	Medicine Research Experimental	Neurosciences
Physics Particles Fields	Biology	Psychiatry	Microbiology	Linguistics
Surgery	Ophthalmology	Endocrinology Metabolism	Marine Freshwater Biology	Biotechnology/ Applied Microbiology
Reproductive Biology	Gastroeneterology Hepatology	Veterinary Sciences	Fisheries	Education/ Educational Research
Obstetrics Gynecology	Genetics Heredity	Plant Sciences	Pediatrics	
Rehabilitation	Biodiversity Conservation	Oncology	Materials Science Multidisciplinary	
Pathology	Zoology	Medicine General Internal	Meteorology/ Atmospheric Sciences	

Table 39 WoS terms excluded from search term Inclusive Economy OR Inclusive Wealth OR Inclusive Growth

Evolution Timeline

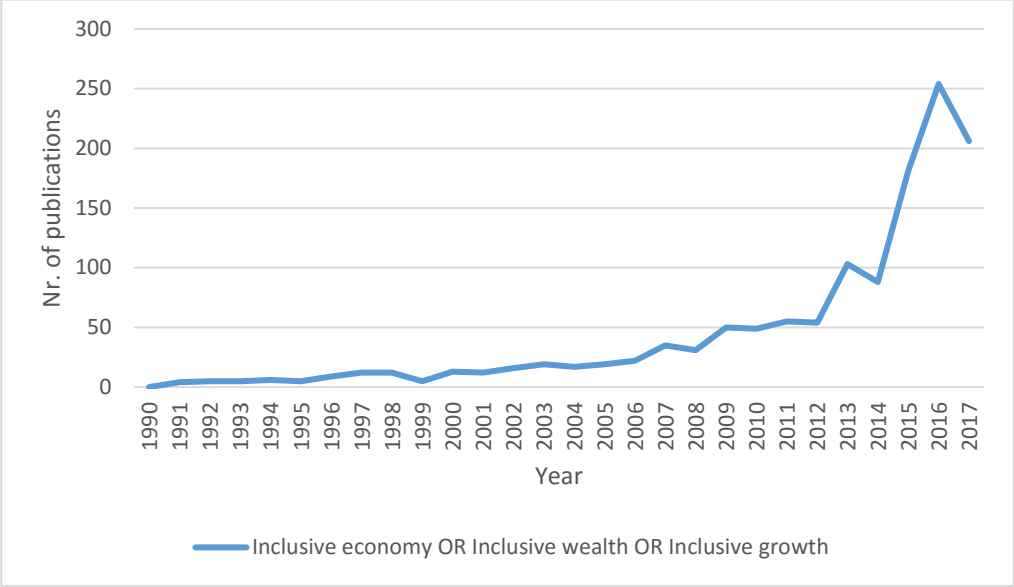

Fig. 61 Evolution of research in the context of Inclusive economy OR Inclusive wealth OR Inclusive growth

Top 10 Research Areas

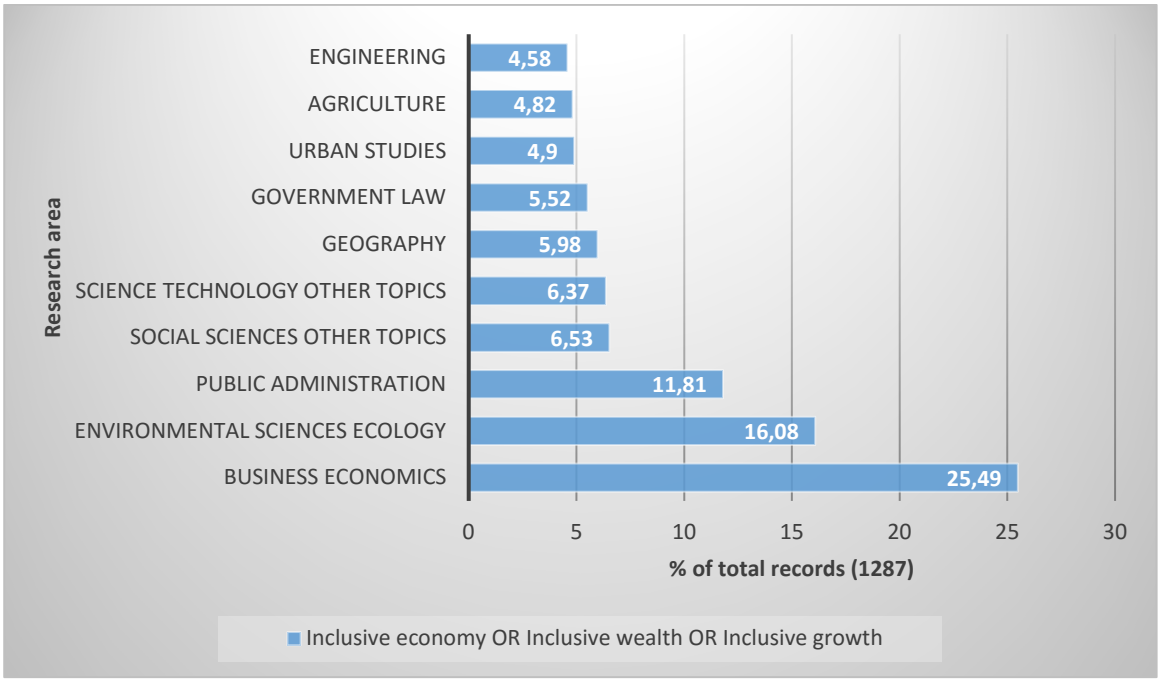

Fig. 62 Top 10 Research Areas in the context of Inclusive economy OR Inclusive wealth OR Inclusive growth

Network visualization

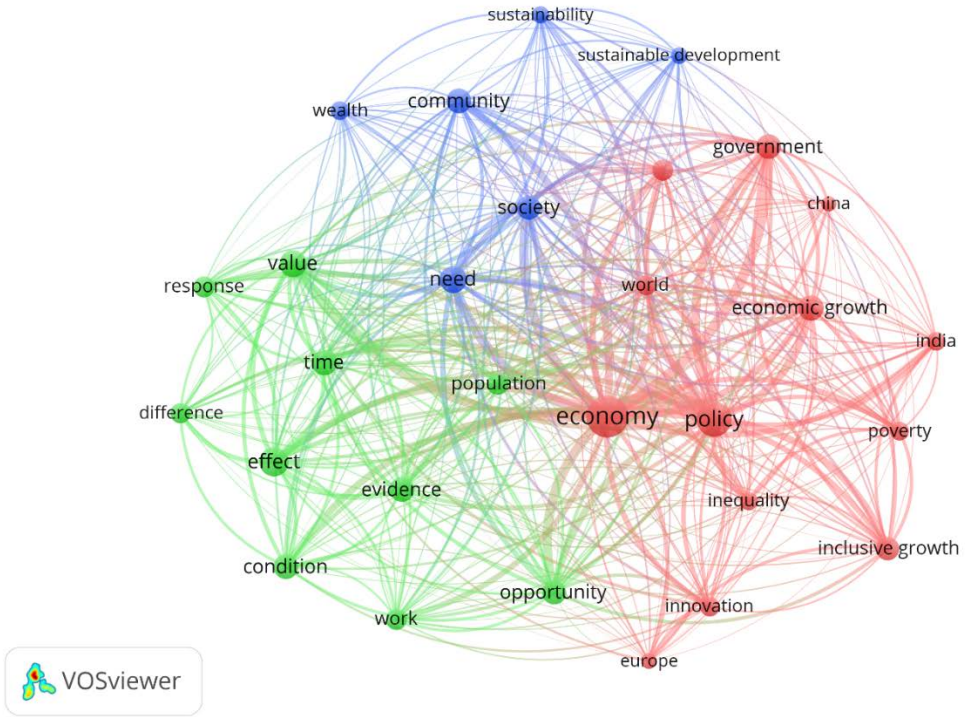

Fig. 63 Network visualization Inclusive economy OR Inclusive wealth OR Inclusive growth

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
China	57	181	Condition	147	410	Community	143	440
Economic growth	153	545	Difference	102	255	Need	177	590
Economy	422	1270	Effect	204	523	Society	135	493
Europe	62	223	Opportunity	142	523	Sustainability	74	261
Governance	106	384	Population	115	341	Sustainable development	66	241
Government	146	557	Response	106	295	Wealth	84	221
Inclusive growth	129	426	Time	151	442			
India	87	310	Value	176	536			
Inequality	81	309	Work	104	318			
Innovation	93	338						
Policy	295	1017						
Poverty	82	321						
World	94	347						

Table 40 Cluster and term specification Inclusive economy OR Inclusive wealth OR Inclusive growth

Search term: Degrwoth 1990-2017

WoS Categories excluded from search

None

Evolution Timeline

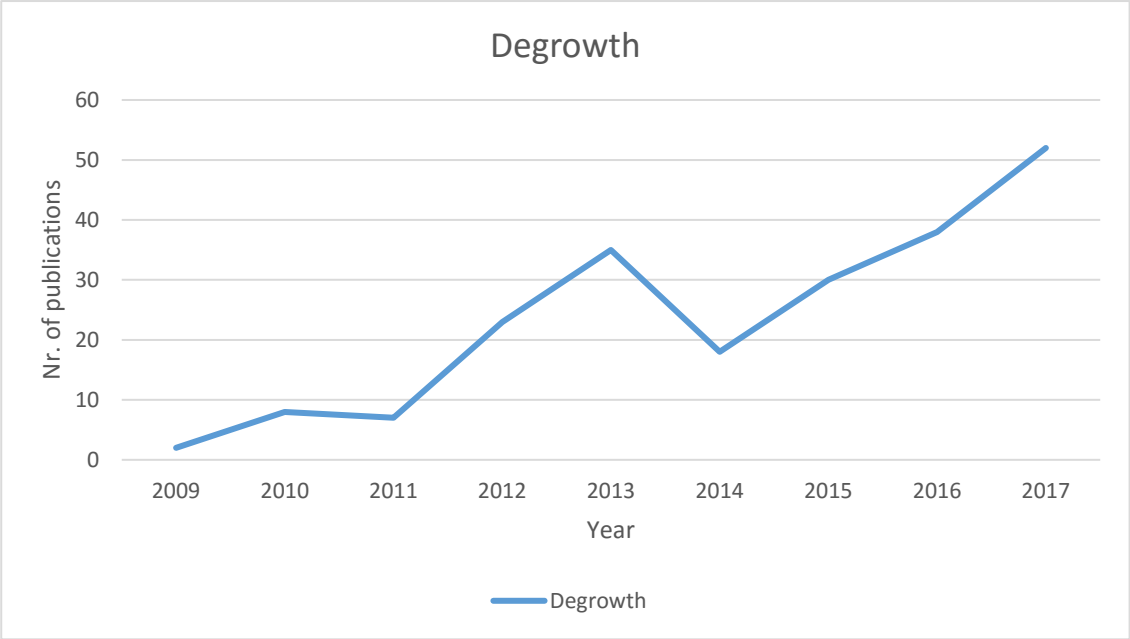

Fig. 64 Evolution of research in the context of Degrowth

Top 10 Research Areas

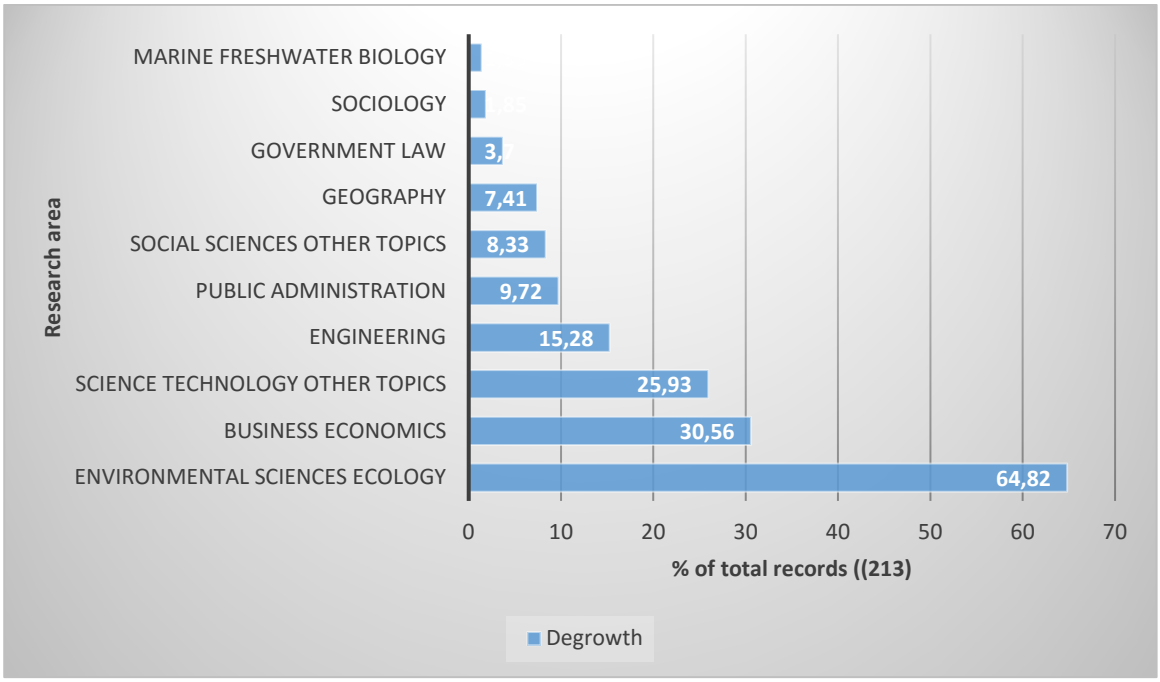

Fig. 65 Top 10 Research Areas in the context of Degrowth

Network visualization

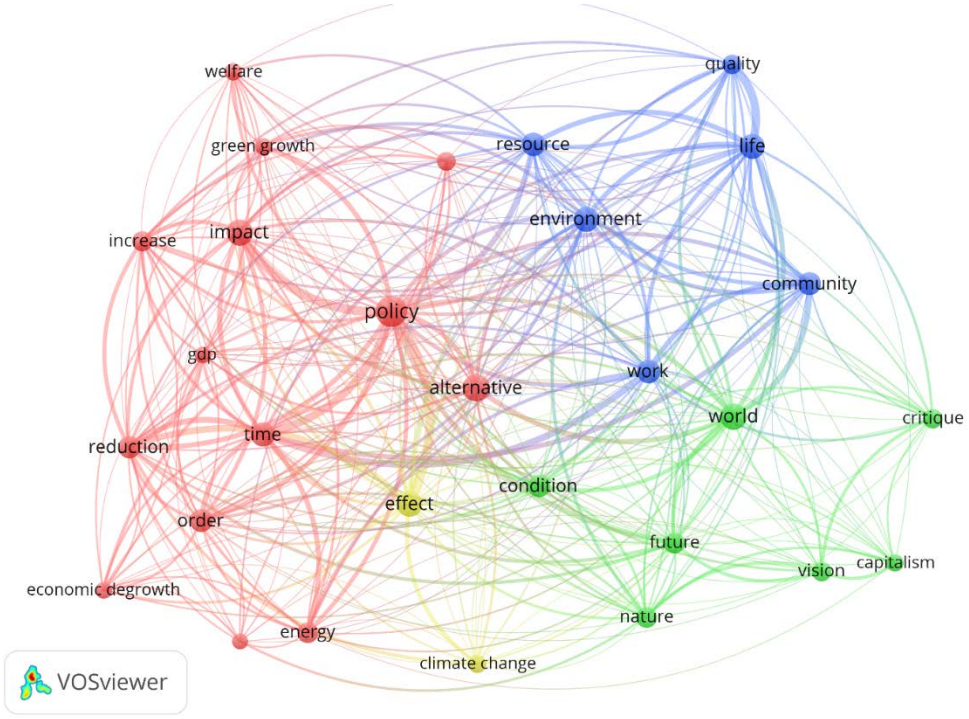

Fig. 66 Network visualization Degrowth

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Alternative	31	62	Capitalism	13	25	Community	22	64	Climate change	14	33
Economic degrowth	12	35	Condition	21	49	Environment	26	67	Effect	28	83
Energy	18	50	Critique	16	32	Life	27	78			
GDP	12	43	Future	18	55	Quality	16	53			
Green growth	12	35	Nature	18	50	Resource	24	72			
Impact	29	79	Vision	16	35	Work	24	68			
Increase	17	58	World	29	79						
Order	22	60									
Policy	41	133									
Reduction	21	78									
Sustainable degrowth	11	25									
Sustainable development	15	35									
Time	25	91									
Welfare	13	33									

Table 41 Cluster and term specification Degrowth

Search term: Adaptive Governance 1990-2017

WoS Categories excluded from search

None

Evolution Timeline

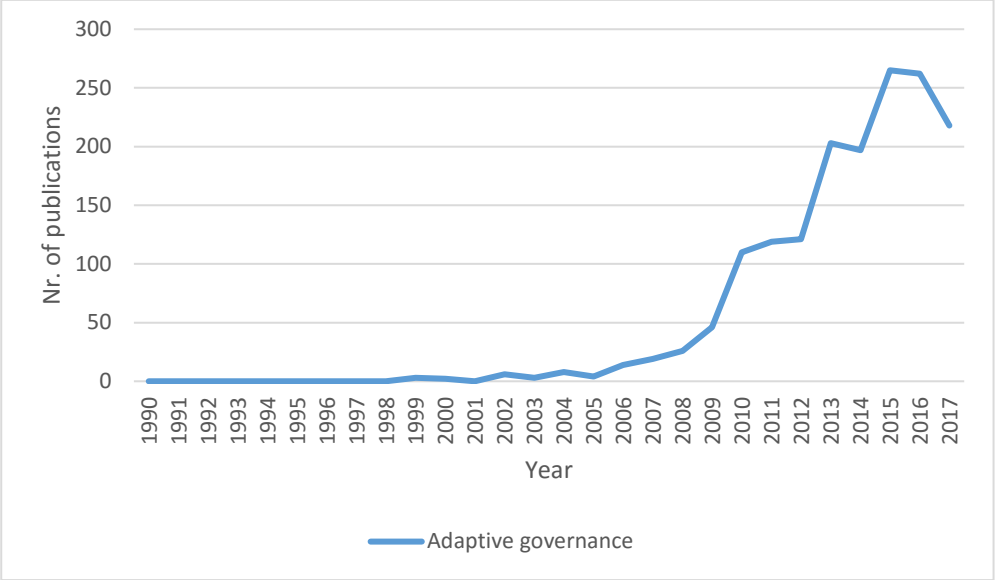

Fig. 67 Evolution of research in the context of Adaptive Governance

Top 10 Research Areas

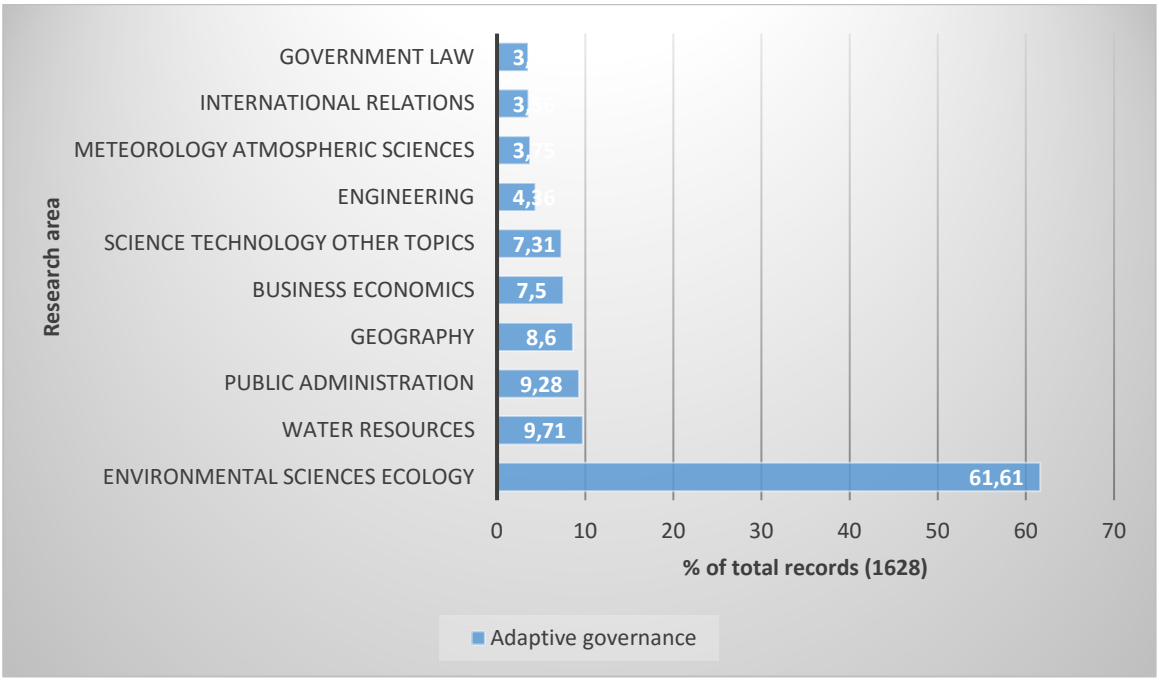

Fig. 68 Top 10 Research Areas in the context of Adaptive Governance

Network visualization

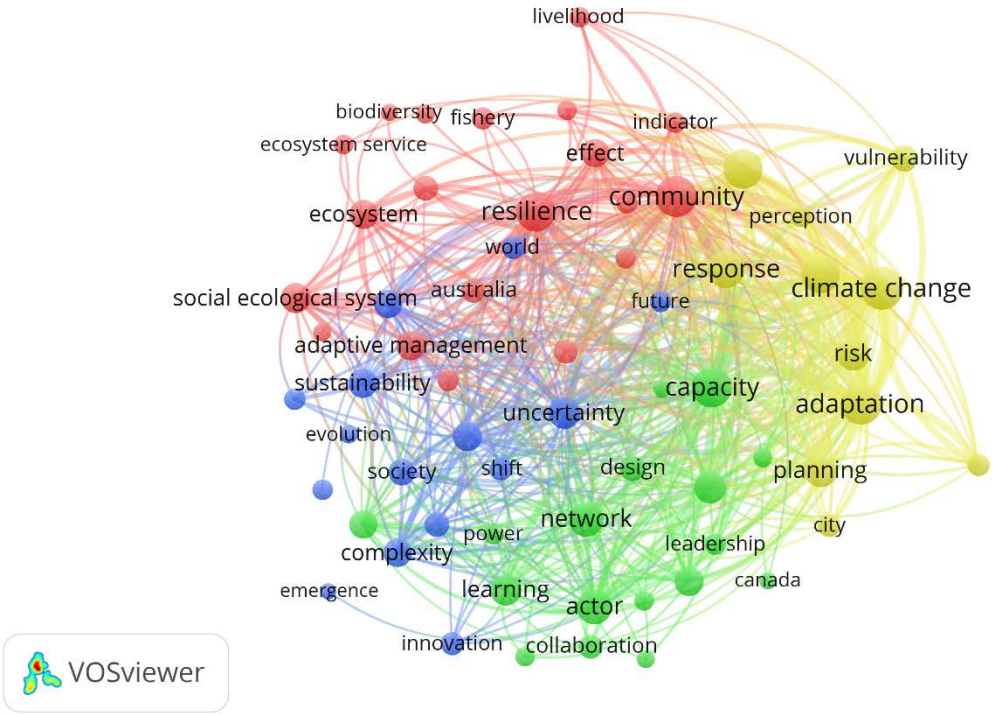

Fig. 69 Network visualization Adaptive Governance

Cluster and Term specification

Cluster 1			**Cluster 2**			**Cluster 3**			**Cluster 4**		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Adaptive management	171	983	Actor	253	1503	Complexity	160	921	Adaptation	332	2123
Australia	114	758	Adaptive governance	157	949	Dynamic	165	1015	Adaptive capacity	293	1824
Biodiversity	61	429	Canada	58	392	Emergence	55	337	City	109	646
Community	334	2006	Capacity	320	2105	Evolution	65	320	Climate change	364	2406
Conservation	122	729	Collaboration	119	664	Future	93	599	Climate change adaptation	105	729
Diversity	94	582	Design	131	711	Innovation	112	629	Impact	309	1945
Ecosystem	167	1080	Flexibility	69	458	Nature	127	747	Perception	97	624
Ecosystem service	77	484	Government	201	1190	Science	169	1030	Planning	215	1334
Effect	160	904	Leadership	92	582	Shift	109	682	Response	287	1801

Effectiveness	95	563	Learning	188	1132	Society	141	794	Risk	212	1309
Environmental change	79	541	Network	237	1435	Sustainability	172	972	Vulnerability	143	951
Fishery	101	570	Participation	171	972	Transformation	96	666			
Indicator	89	515	Power	83	464	Transition	85	481			
Integration	119	699	Responsibility	71	440	Uncertainty	207	1339			
Livelihood	86	554	Social learning	79	494	World	109	680			
Natural resource	72	452	Trust	67	427						
Natural resource management	68	412	Water management	77	421						
Performance	87	388									
Resilience	313	1976									
Social ecological system	183	1164									

Table 42 Cluster and term specification Adaptive Governance

Search term: Social Cohesion 1990-2017

WoS Categories excluded from search

None

Evolution Timeline

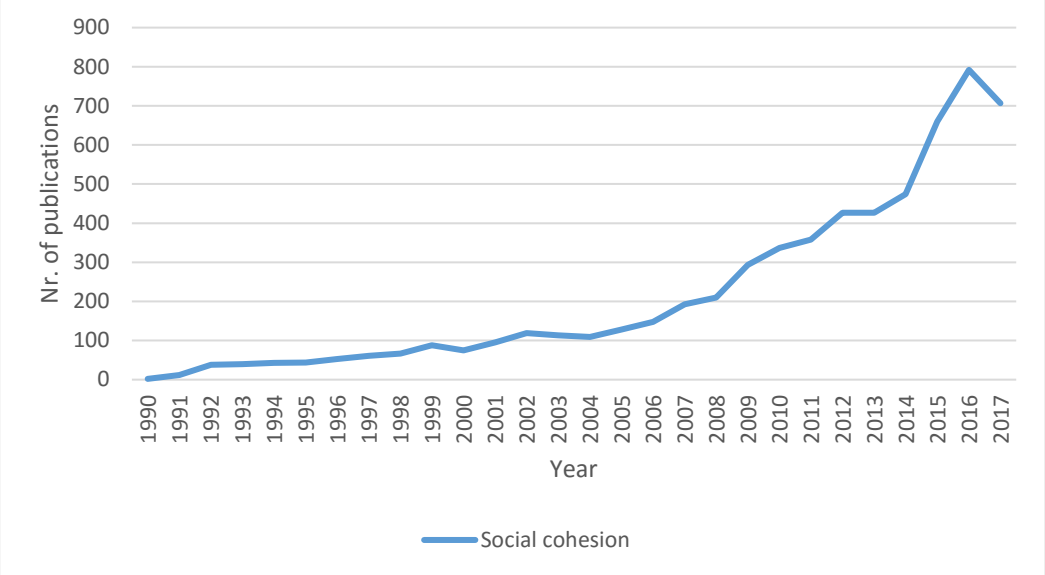

Fig. 70 Evolution of research in the context of Social Cohesion

Top 10 Research Areas

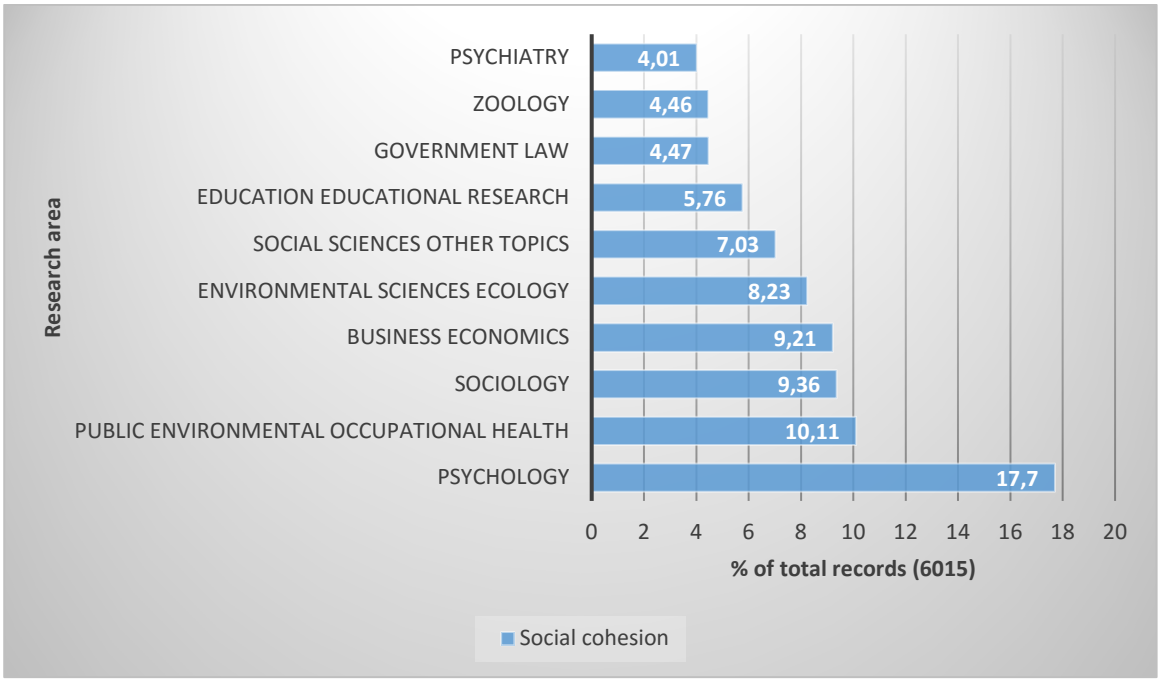

Fig. 71 Top 10 Research Areas in the context of Social Cohesion

Network visualization

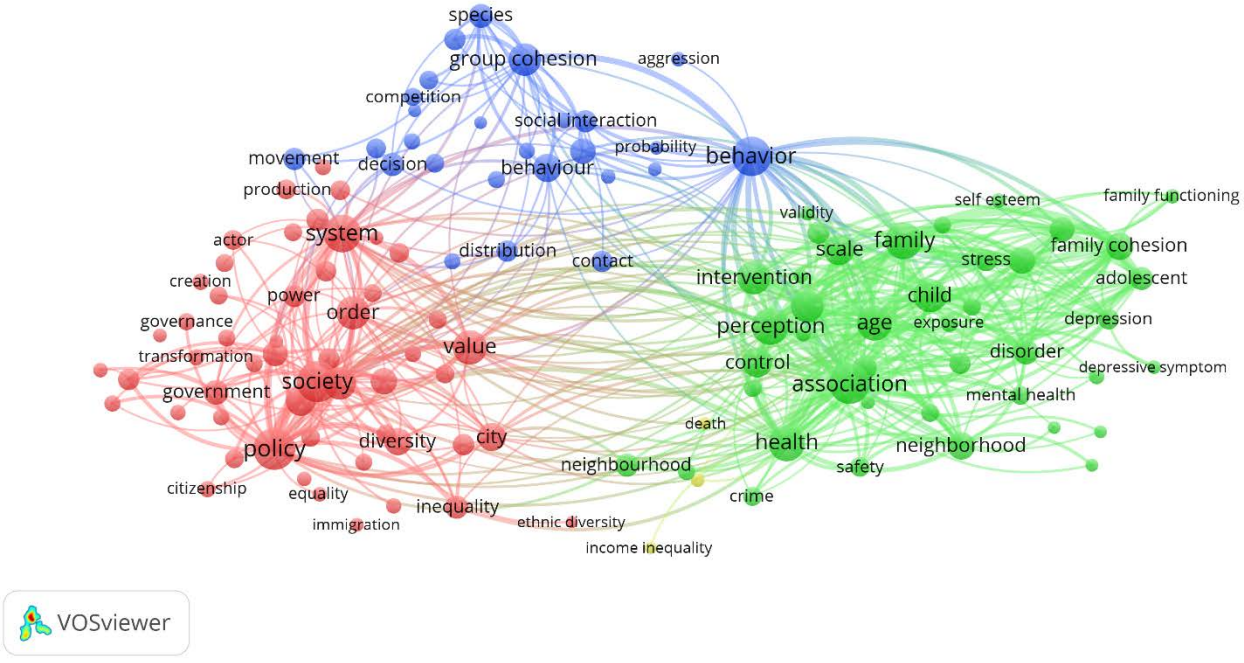

Fig. 72 Network visualization Social Cohesion

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Actor	143	624	Adjustment	121	689	Aggression	77	373
Assumption	120	567	Adolescent	195	1290	Behavior	549	2425
Capacity	158	750	Age	452	2541	Behaviour	294	1328
Citizen	126	663	Anxiety	107	628	Choice	99	425
Citizenship	100	496	Association	576	3085	Cohesiveness	93	338
City	296	1459	Child	400	2290	Communication	236	1077
Collaboration	93	379	Collective efficacy	68	309	Competition	119	511
Community cohesion	169	734	Control	319	1656	Contact	167	699
Competitiveness	76	372	Crime	127	607	Cost	139	654
Complexity	74	341	Depression	153	986	Decision	200	936
Construction	120	517	Depressive symptom	69	504	Distribution	169	762
Cooperation	144	590	Disorder	230	1334	Food	78	402
Creation	98	445	Ethnicity	106	609	Group cohesion	386	1445
Culture	248	1132	Exposure	106	562	Group member	163	658
Democracy	91	432	Family	494	2701	Leadership	127	545
Diversity	274	1165	Family cohesion	268	1577	Maintenance	105	496
Economic development	66	280	Family functioning	75	519	Movement	186	805
Economy	171	794	Friend	81	429	Probability	74	350
Emergence	117	575	Gender	204	1117	Social group	129	570
Employment	98	459	Health	474	2528	Social interaction	179	792
Equality	81	425	Home	122	685	Social network analysis	62	202
Ethnic diversity	57	222	Intervention	400	1940	Social organization	58	284
European Union	101	459	Likelihood	79	401	Social relationship	85	402
Failure	70	349	Mental health	128	781	Social structure	97	429
Formation	177	717	Neighborhood	189	852	Species	212	886
Governance	113	515	Neighborhood characteristic	64	431	Team cohesion	74	214
Government	218	1072	Neighborhood cohesion	65	387			
Growth	221	1065	Neighborhood social cohesion	58	344			
Hand	122	561	Neighbourhood	189	852			
Identity	380	1623	Parent	226	1467			
Immigration	66	317	Perception	480	2321			
Inclusion	135	654	Regression analysis	170	907			
Inequality	191	961	Risk	371	2002			
Integration	318	1380	Risk factor	88	564			

Language	101	438	Safety	145	804			
Learning	141	594	Satisfaction	184	792			
Migration	105	541	Scale	342	1715			
Nation	76	370	Self esteem	82	512			
Order	397	1892	Social environment	114	666			
Policy	624	2756	Social support	248	1312			
Power	175	825	Stress	176	944			
Production	139	572	Validity	79	337			
Religion	85	366						
Society	595	2551						
Solidarity	126	545	** death	64	304			
Sustainability	104	446	** income inequality	55	250			
System	516	2339	** mortality	69	368			
Technology	114	486						
Tension	105	507						
Threat	129	639						
Transformation	102	500						
Value	430	1956						
World	172	812						

Table 43 Cluster and network specification Social Cohesion

Search term: Social Ecological Systems 1990-2017

WoS Categories excluded from search

None

Evolution Timeline

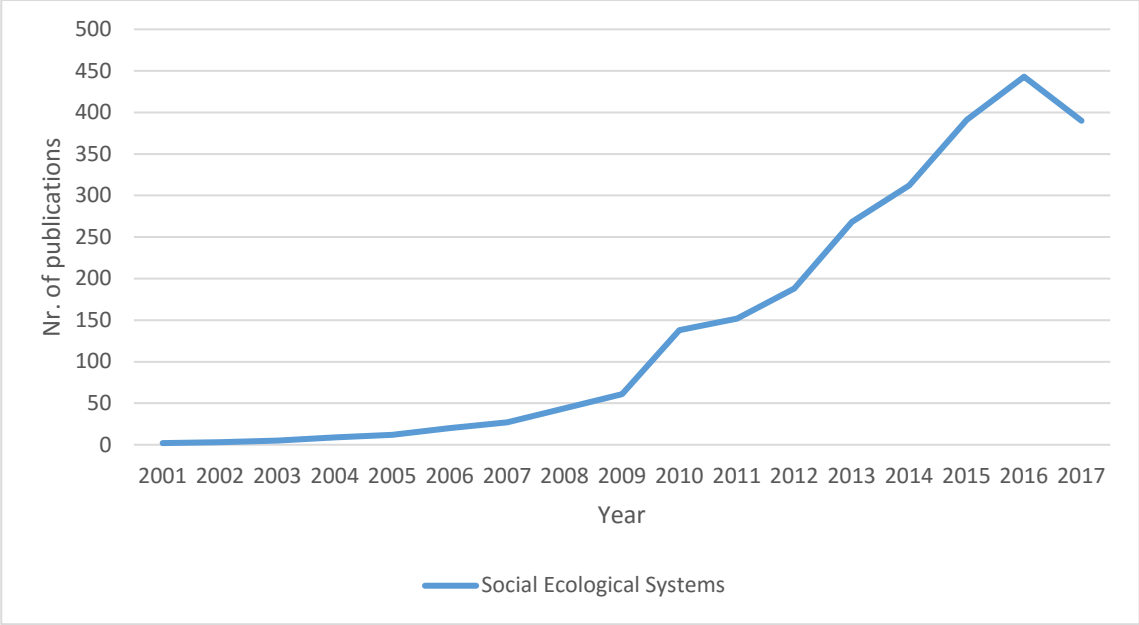

Fig. 73 Evolution of research in the context of Social Ecological Systems

Top 10 Research Areas

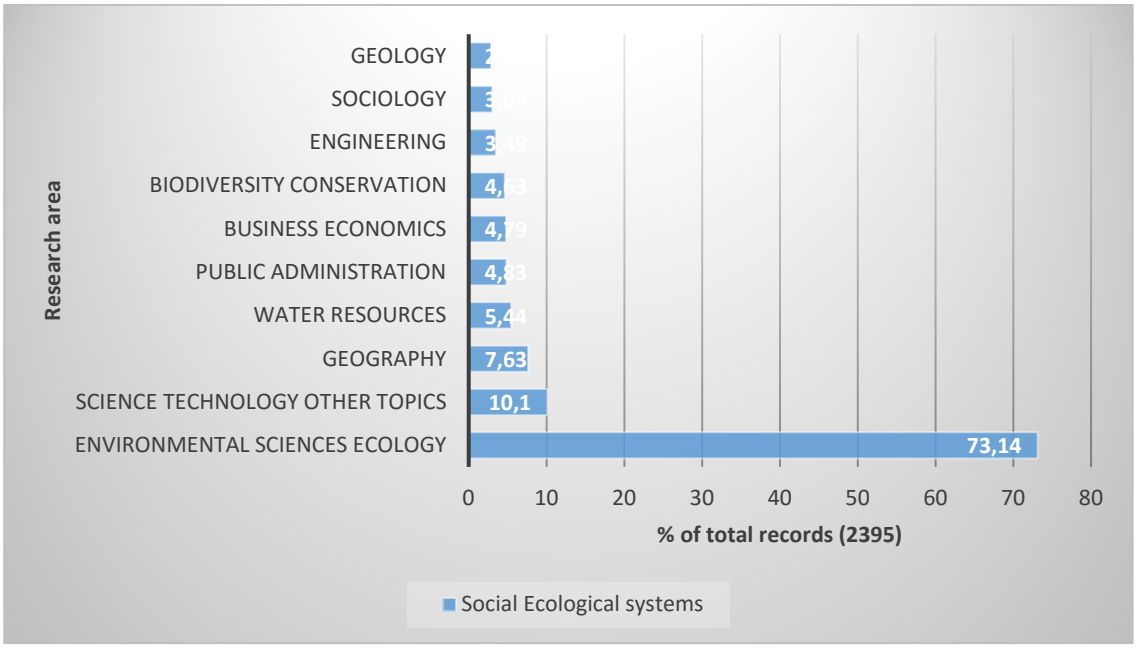

Fig. 74 Top 10 Research Areas in the context of Social Ecological Systems

Network visualization

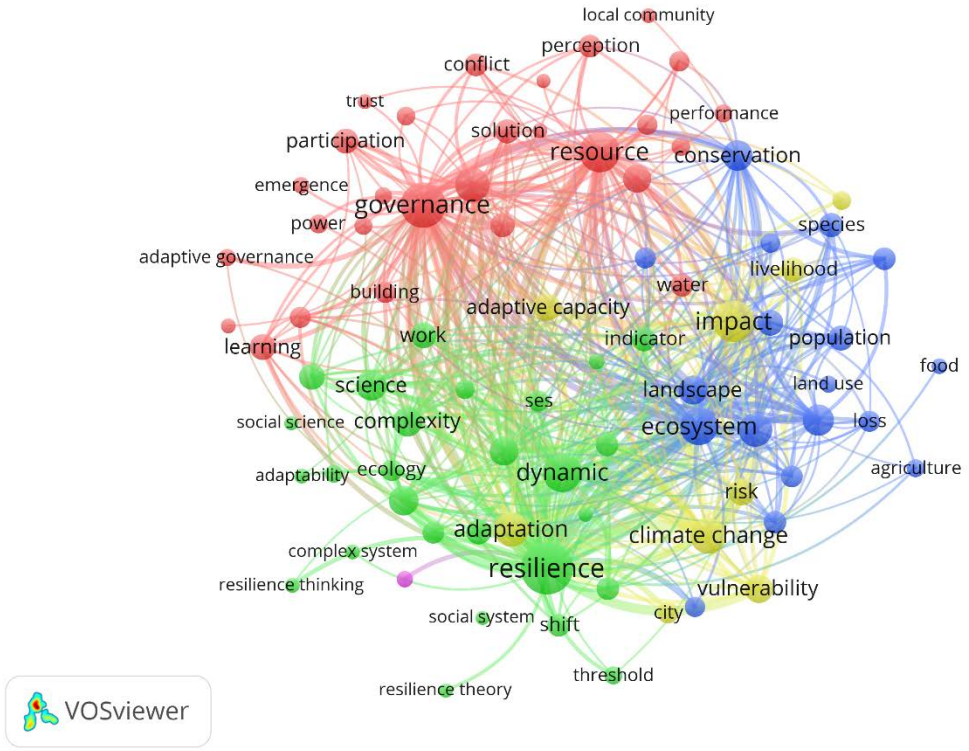

Fig. 75 Network visualization Social Ecological Systems

Cluster and Term specification

Cluster 1			Cluster 2			Cluster 3			Cluster 4		
Term	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**	**Term**	**Occurrence**	**Link strength**
Adaptive governance	83	527	Adaptability	63	430	Agriculture	89	545	Adaptation	313	1854
Adaptive management	117	715	Complex social ecological system	100	567	Biodiversity	138	850	Adaptive capacity	196	1251
Building	123	733	Complex system	61	347	Consequence	126	861	City	123	618
Common pool resource	55	260	Complexity	230	1349	Conservation	252	1486	Climate change	335	2104
Communication	93	535	Decision maker	69	437	Disturbance	112	675	Impact	448	2630
Conflict	136	748	Dynamic	399	2314	Ecosystem	376	2323	Livelihood	161	973
Cost	92	538	Ecology	131	730	Ecosystem service	264	1587	Risk	190	1185
Design	157	811	Feedback	135	859	Effect	292	1733	Threat	92	586
Effectiveness	112	618	Human	141	857	Food	65	413	Vulnerability	209	1277
Emergence	76	406	Indicator	157	872	Forest	121	695			
Fishery	208	1145	Integration	176	971	Land use	81	529			
Governance	549	2998	Multiple scale	53	350	Landscape	220	1299			
Governance system	81	483	Resilience	728	3948	Loss	119	774			
Learning	178	1009	Resilience theory	53	329	Population	170	986			
Local community	62	355	Resilience thinking	62	385	Production	177	1073			
Natural resource	111	652	Science	246	1390	Scenario	134	843			
Natural resource management	85	452	SES	116	619	Species	155	905			
Participation	162	888	Shift	139	850	Trade off	105	685			
Perception	137	747	Social science	54	293						
Performance	88	466	Social system	55	324						
Power	94	543	Society	217	1308						
Resource	437	2510	Sustainable development	87	536						

Social capital	57	332	Threshold	84	528						
Social learning	57	375	Transformation	166	1008						
Solution	153	926	Transition	125	749						
Stakeholder	308	1805	Uncertainty	237	1540						
Trust	63	377	Work	175	884						
Water	141	827									
			* Social ecological resilience	73	461						

Table 44 Cluster and term specifications Social Ecological Systems

3.Bibliographic Coupling Network Analysis

3.1 VOSviewer specifications for bibliographic coupling network analysis

Group 1	Risk 1990-2000	Risk 2001-2010	Risk 2011-2017*	Sustainability	Resilience	Risk AND Sustainability	Risk AND Resilience	Risk AND Sustainability AND Resilience	
Total nr records	17729	56622	143825	63390	24533	5052	3993	373	
Nr records w/errors	0	1000	4000	1000	500	0	500	0	
Fractional counting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Min nr documents p/author	10	20	40	20	15	5	5	3	
Threshold author	92	116	158	162	77	64	66	18	
Final nr authors selected	92	116	158	162	77	64	66	18	
Min nr documents p/country	10	50	50	50	15	10	10	5	
Threshold country	59	67	90	88	94	66	52	26	
Final nr countries selected	59	67	90	88	94	66	52	26	
Min nr documents p/organization	50	200	200	100	50	20	20	5	
Threshold organization	54	60	114	201	199	57	48	15	
Final nr organizations selected	54	60	114	201	199	57	48	15	
Group 2	Ecological Resilience	Spatial Resilience	Engineering Resilience	Infrastructure Resilience	Robustness	Disaster Resilience	Community Resilience	Urban Resilience	(economic) Development Resilience
Total nr records	2000	2316	989	1419	86538	2236	7070	1832	4453
Nr records w/errors	0	0	0	0	6500	0	500	500	0
Fractional counting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min nr documents p/author	5	5	3	5	30	5	8	5	5
Threshold author	43	49	56	40	277	80	53	40	65

Final nr authors selected	43	49	56	40	277	80	53	40	65
Min nr documents p/country	10	5	5	5	50	5	10	5	8
Threshold country	46	56	39	52	70	59	69	45	65
Final nr countries selected	46	56	39	52	70	59	69	45	65
Min nr documents p/organization	15	15	7	10	250	12	20	10	20
Threshold organization	49	43	40	42	68	58	138	32	58
Final nr organizations selected	49	43	40	42	68	58	138	32	58
Group 3	**Planetary Boundaries**	**Natural Capital and Ecoservices**	**Circular Economy**	**Social/ Urban Metabolism**	**Inclusive Economy/ Wealth/Growth**	**Degrowth**	**Adaptive Governance**	**Social Cohesion**	**Social Ecological Systems**
Total nr records	154	4115 and 32	759	1208	1287	213	1623	6015	2395
Nr records w/errors	0	0	0	0	0	0	0	0	0
Fractional counting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min nr documents p/author	3	5	3	5	3	3	5	5	8
Threshold author	27	66	83	49	32	11	86	84	82
Final nr authors selected	27	66	83	49	32	11	86	84	82
Min nr documents p/country	5	5	5	5	5	5	5	5	5
Threshold country	18	86	31	43	49	12	52	59	64
Final nr countries selected	18	86	31	43	49	12	52	59	64
Min nr documents p/organization	5	15	5	10	5	3	10	20	15
Threshold organization	15	65	38	23	72	13	70	64	89
Final nr organizations selected	15	65	38	23	72	13	70	64	89

* For the search term Risk 2011-2017 a random sample of 60% of the records was chosen as the VOSviewer software did not have the memory capacity to process the full data set.

Table 45 VOSviewer specifications for bibliographic coupling network analysis

3.2 Detailed Group 1 Search terms for bibliographic coupling network analysis

Search Term: Risk Assessment OR Risk Management OR Risk Analysis 1990-2000

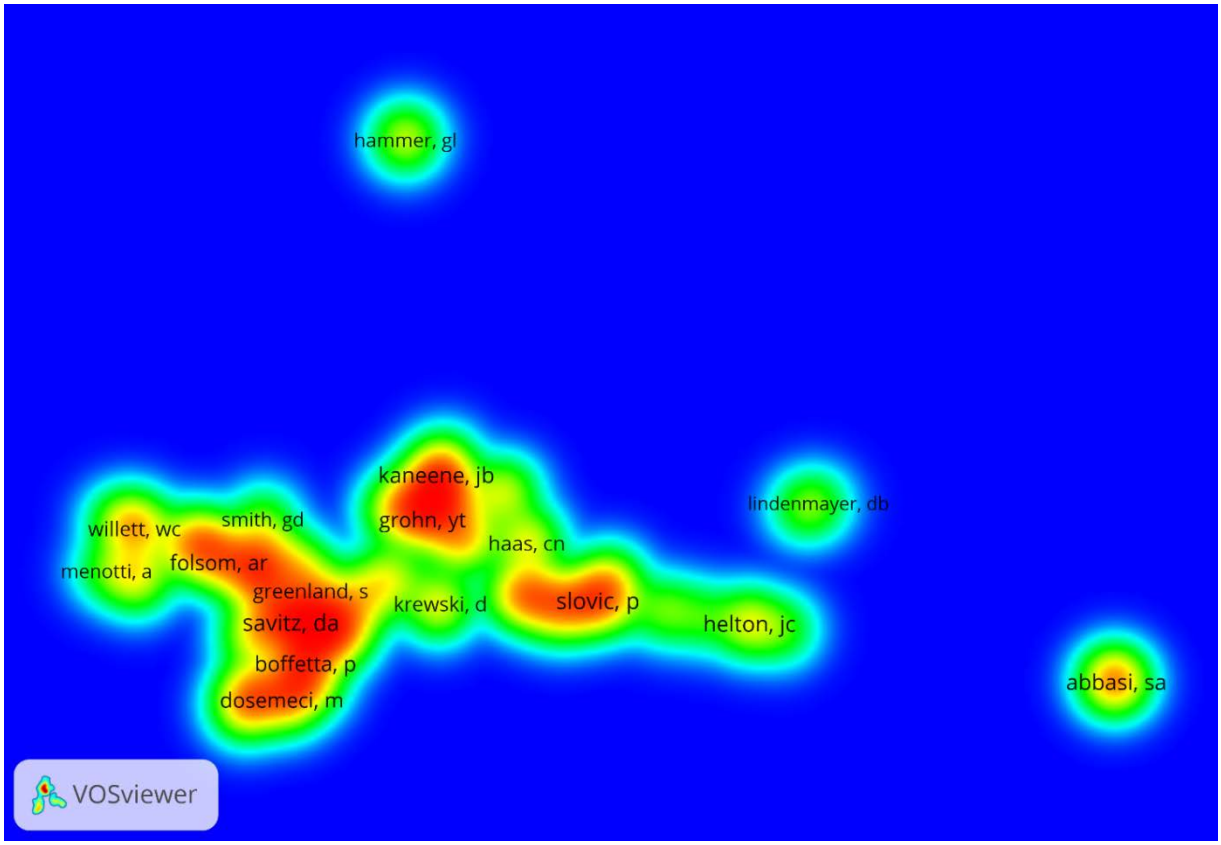

Fig. 76 Risk 1990-2000 bibliographic coupling by author

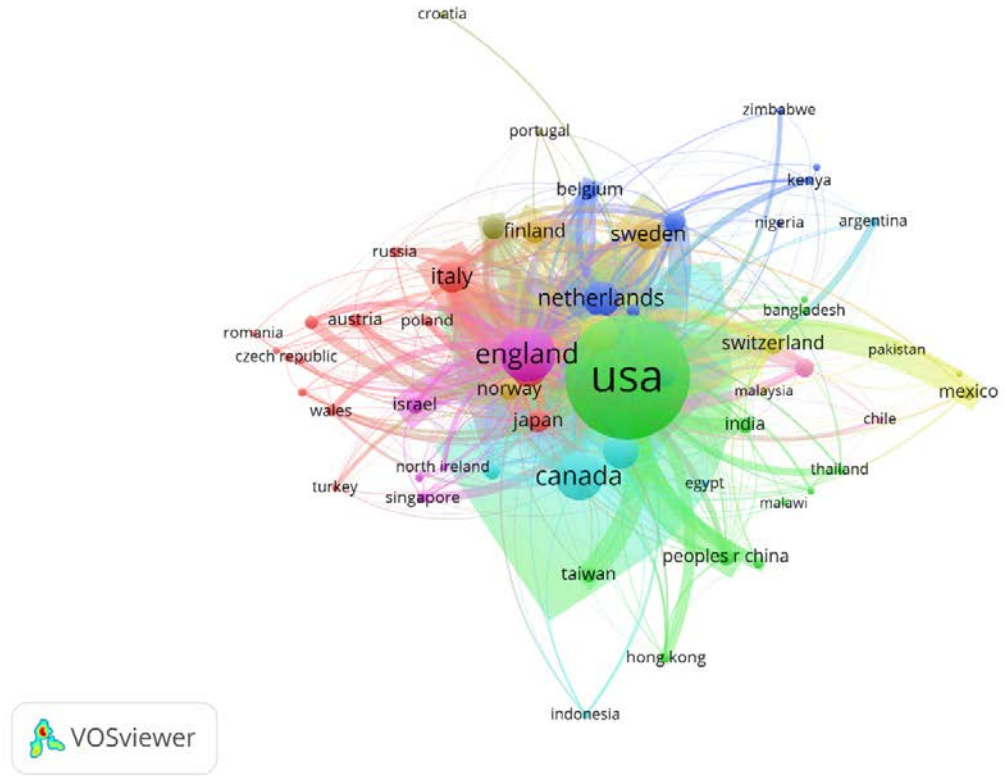

Fig. 77 Risk 1990-2000 bibliographic coupling by country

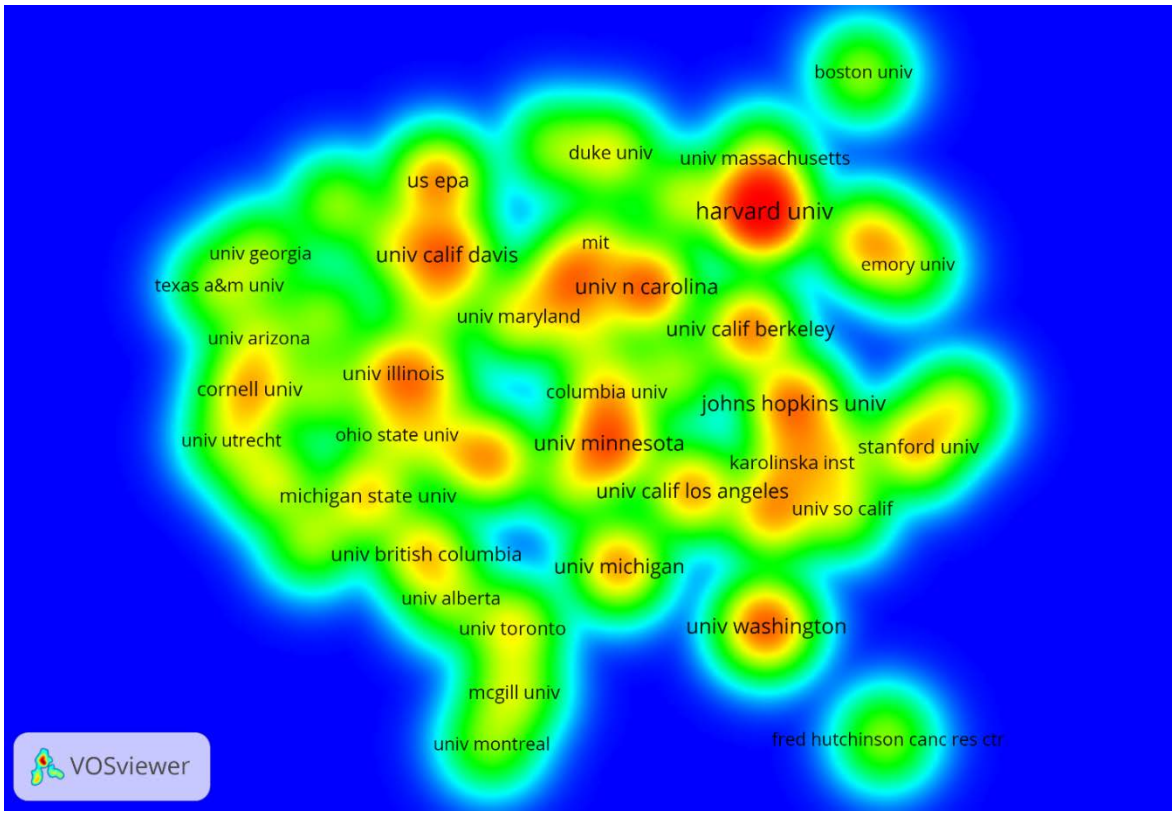

Fig. 78 Risk 1990-2000 bibliographic coupling by organization

Search Term: Risk Assessment OR Risk Management OR Risk Analysis 2001-2010

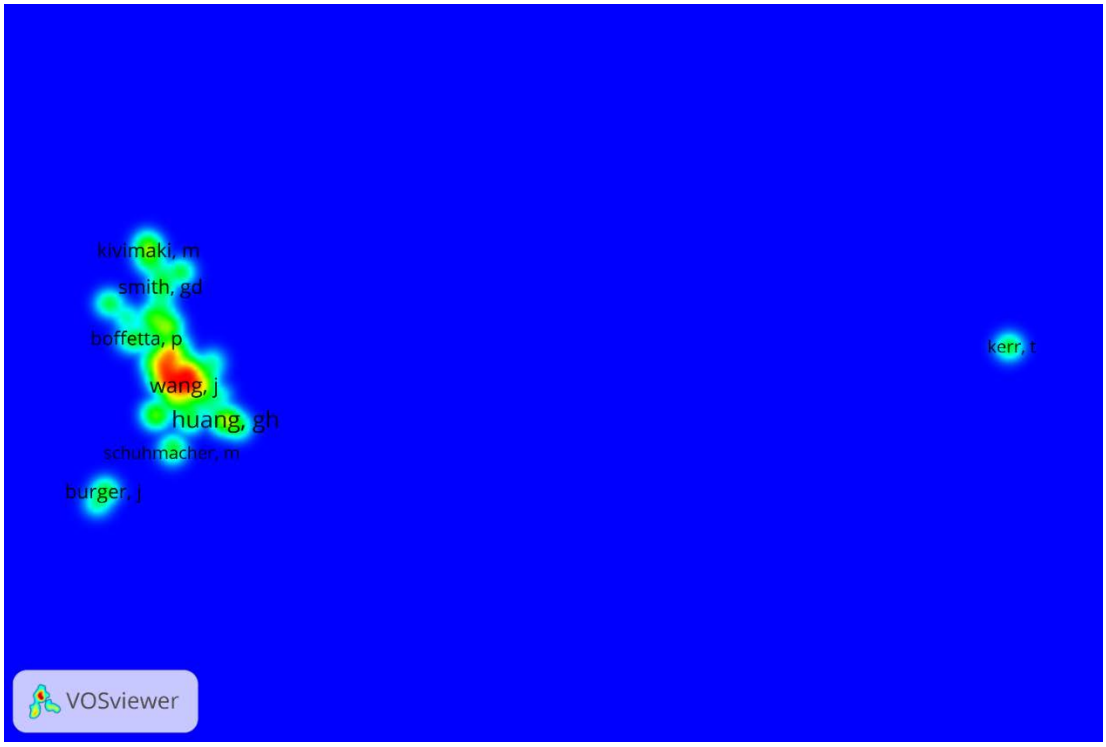

Fig. 79 Risk 2001-2010 bibliographic coupling by author

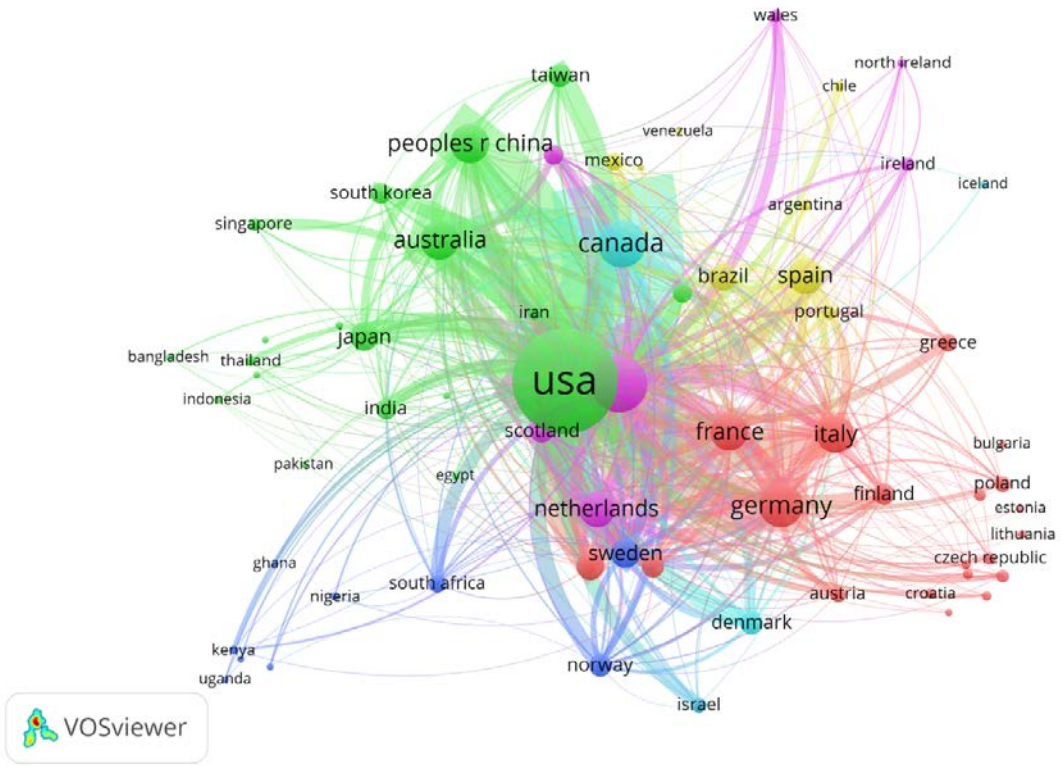

Fig. 80 Risk 2001-2010 bibliographic coupling by country

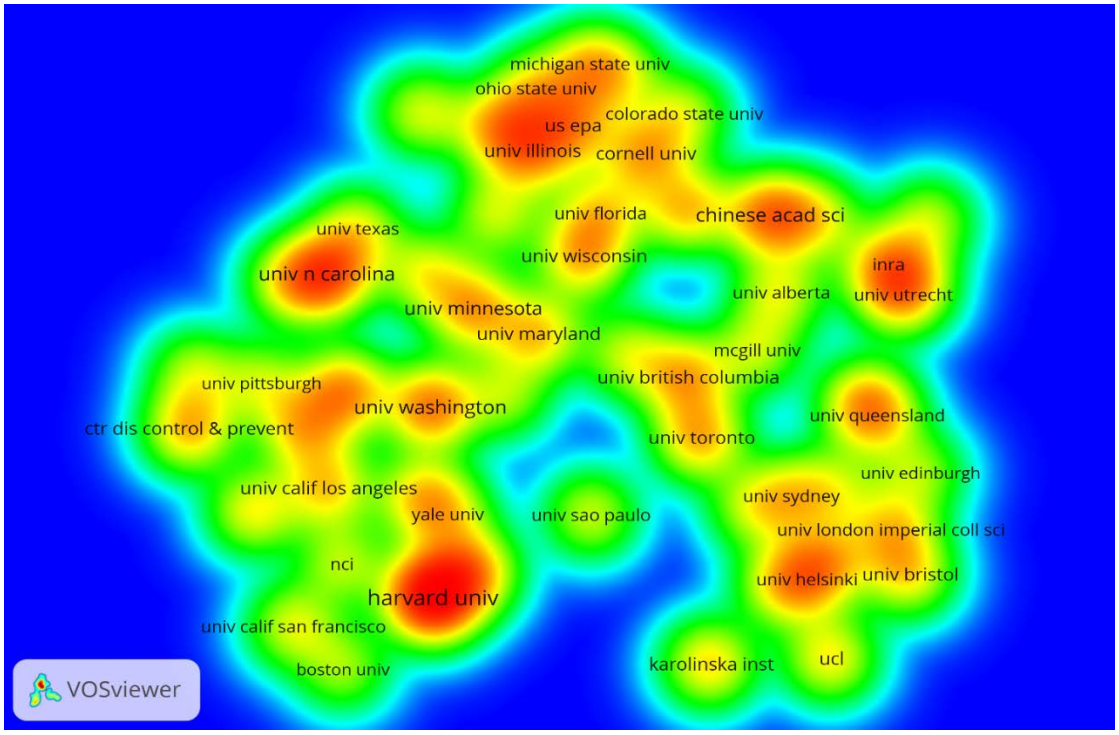

Fig. 81 Risk 2001-2010 bibliographic coupling by organization

Search Term: Risk Assessment OR Risk Management OR Risk Analysis 2011-2017

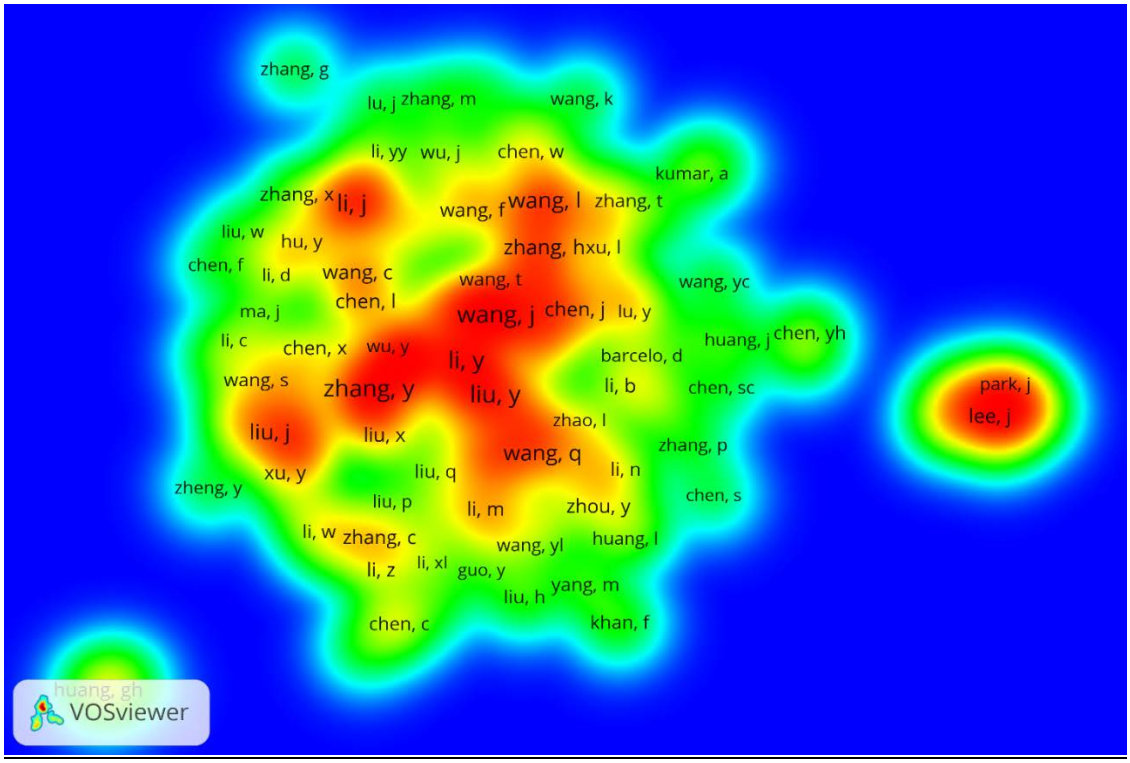

Fig. 82 Risk 2011-2017 bibliographic coupling by author

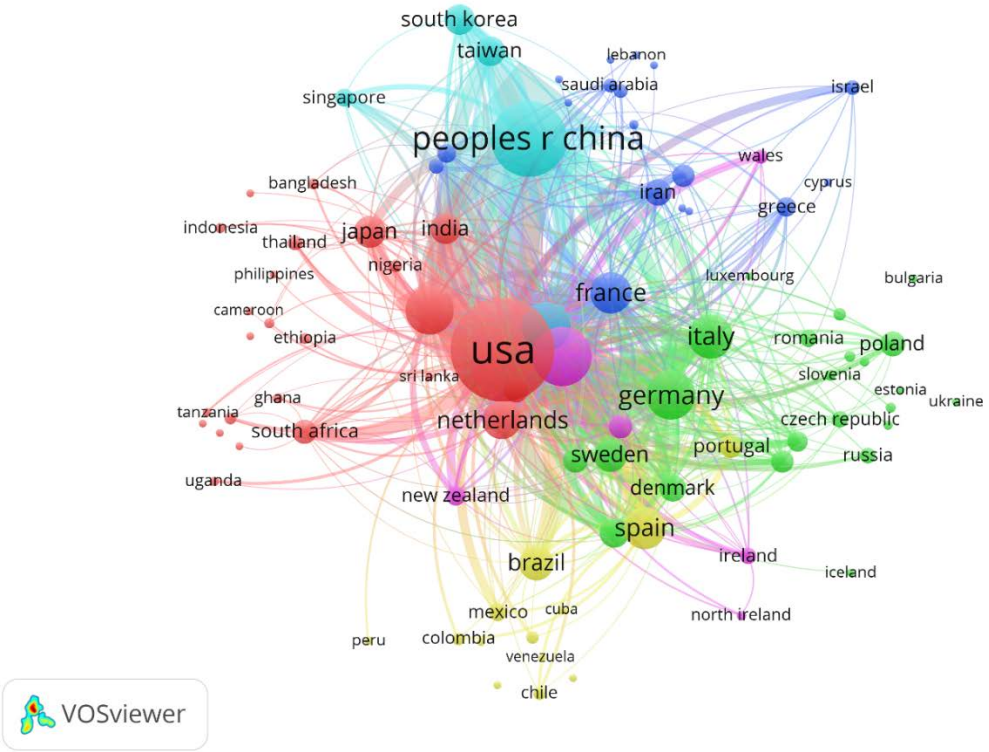

Fig. 83 Risk 2011-2017 bibliographic coupling by country

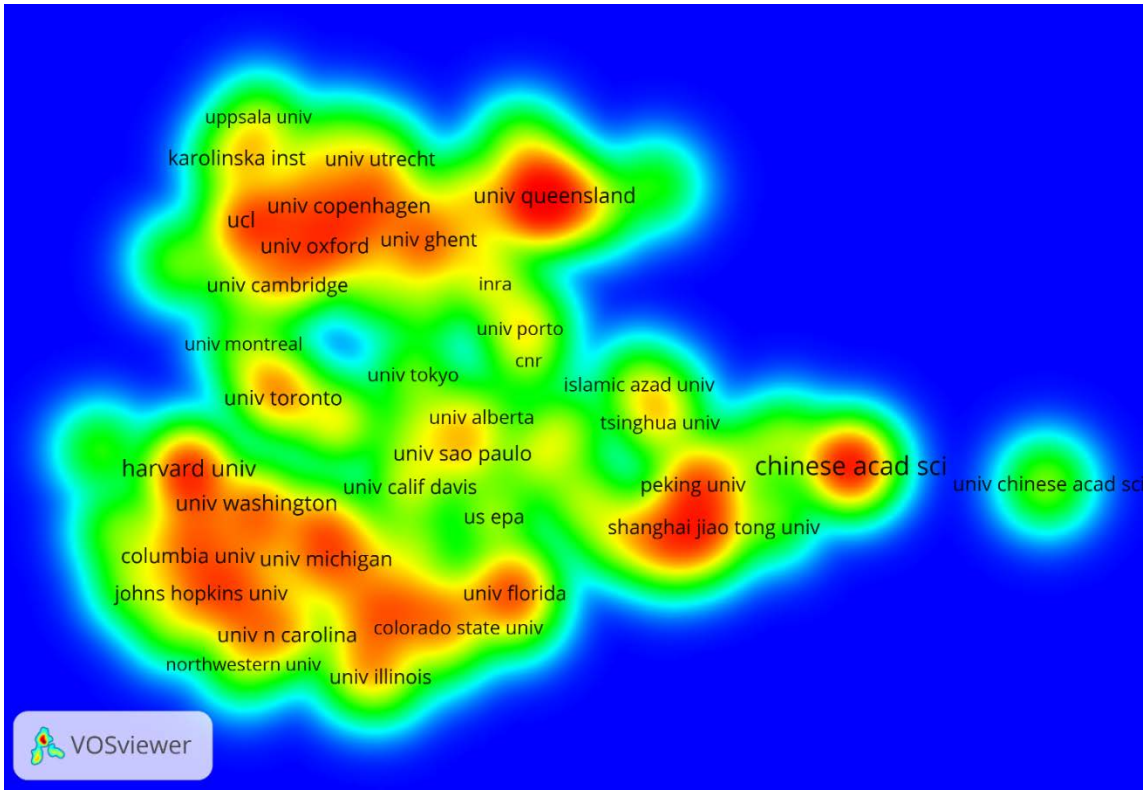

Fig. 84 Risk 2011-2017 bibliographic coupling by organization

Search Term: Sustainability 1990-2017

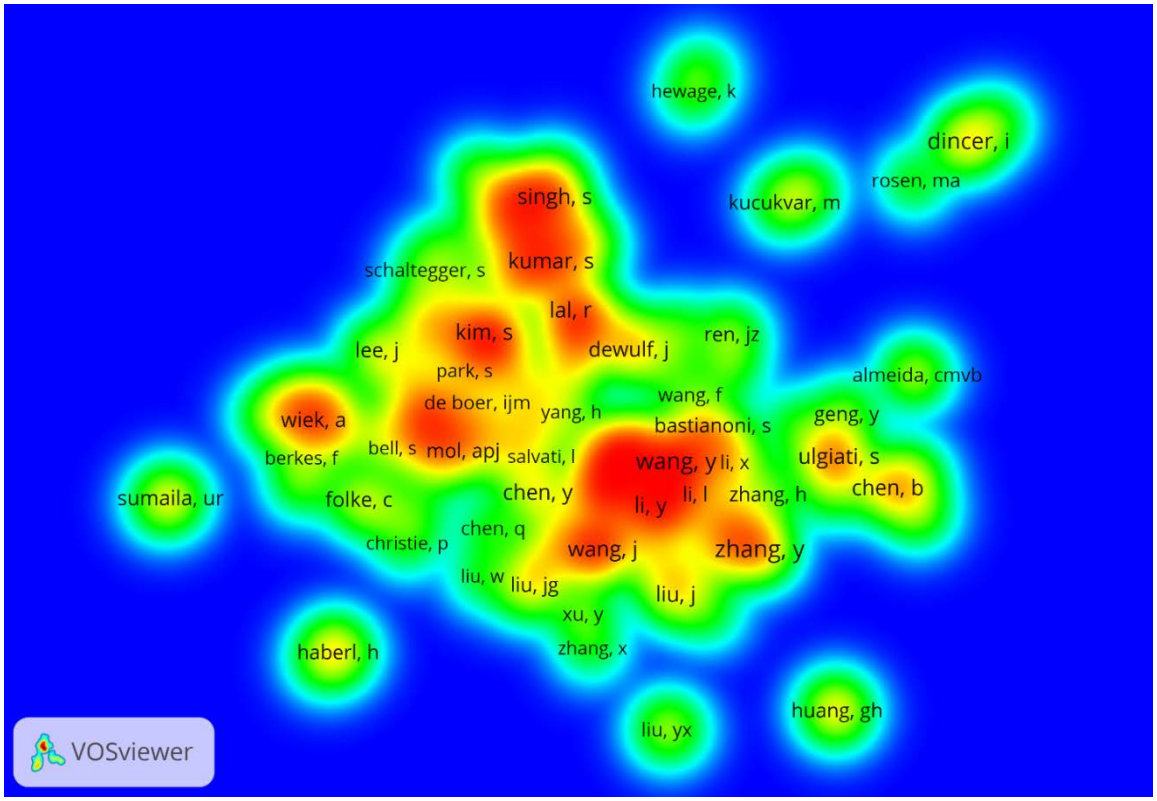

Fig. 85 Sustainability bibliographic coupling by author

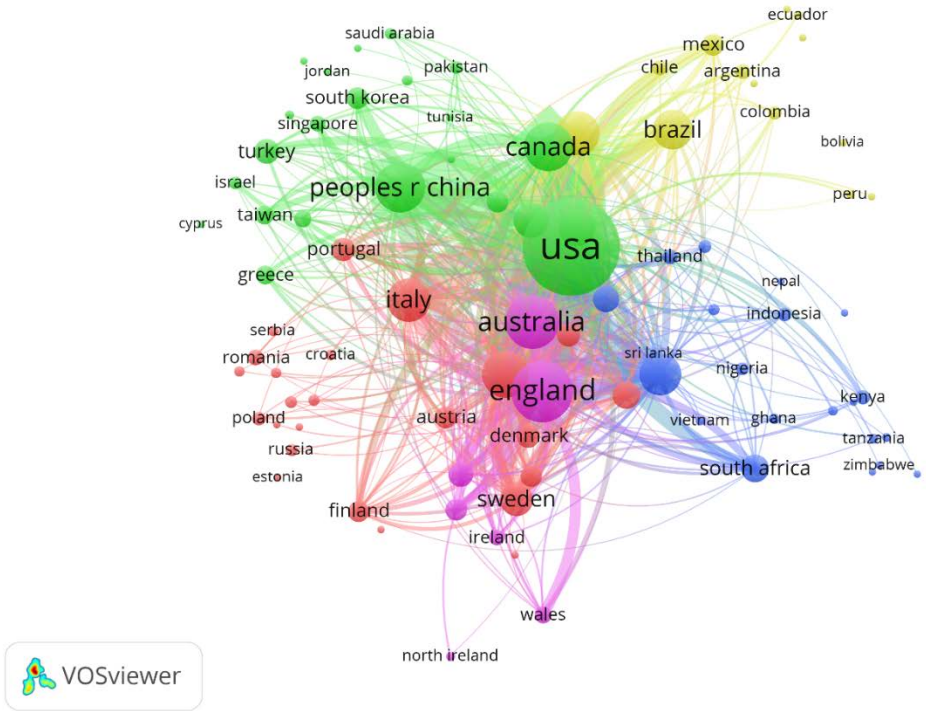

Fig. 86 Sustainability bibliographic coupling by country

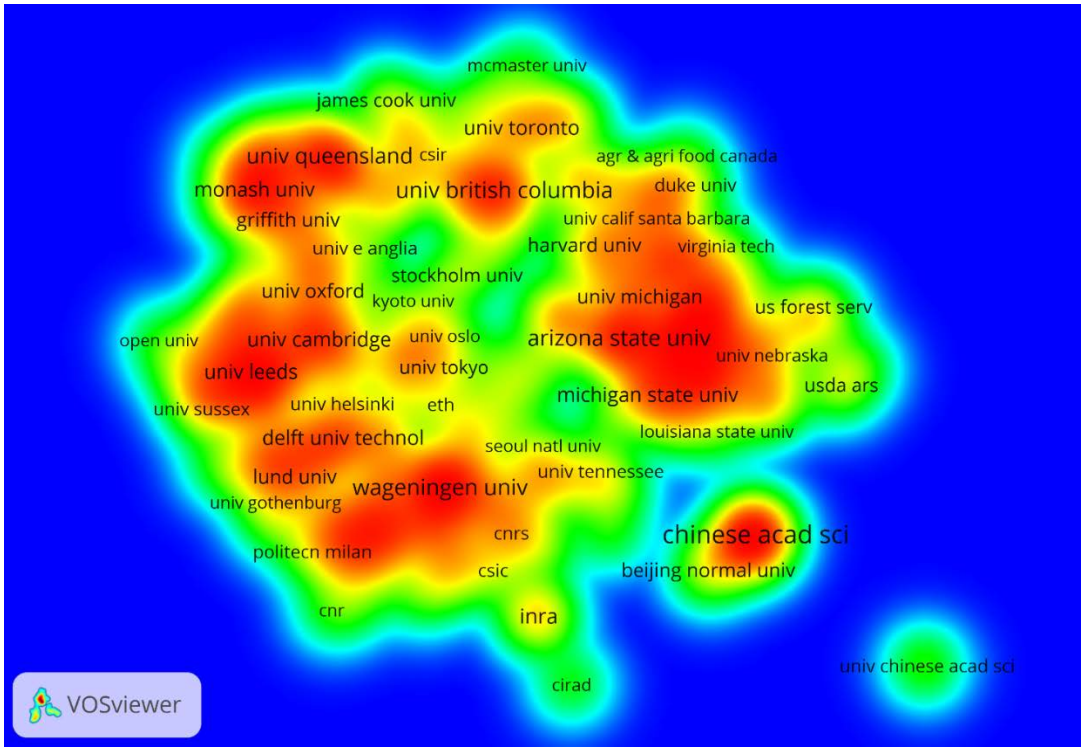

Fig. 87 Sustainability bibliographic coupling by organization

Search Term: Resilience 1990-2017

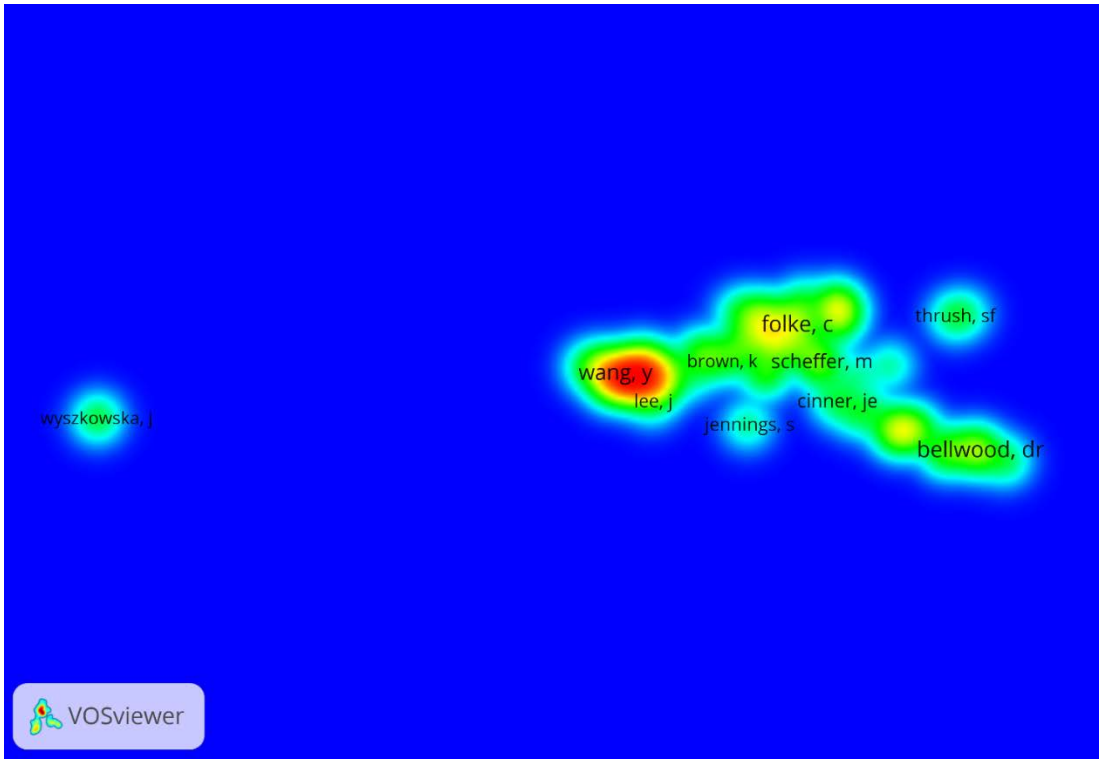

Fig. 88 Resilience bibliographic coupling by author

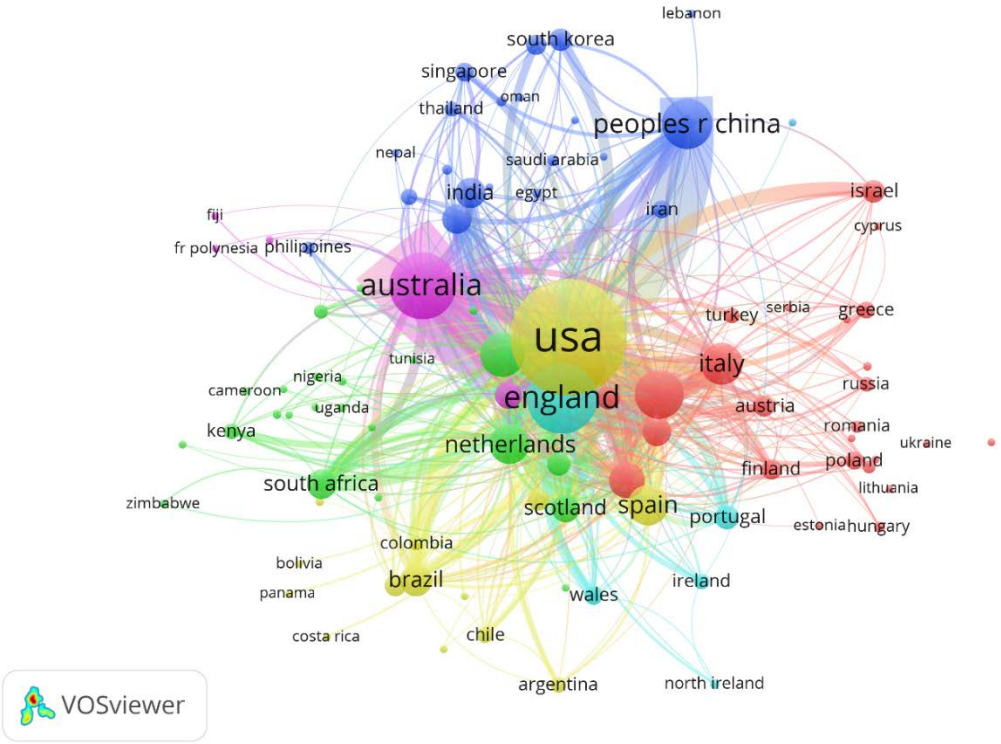

Fig. 89 Resilience bibliographic coupling by country

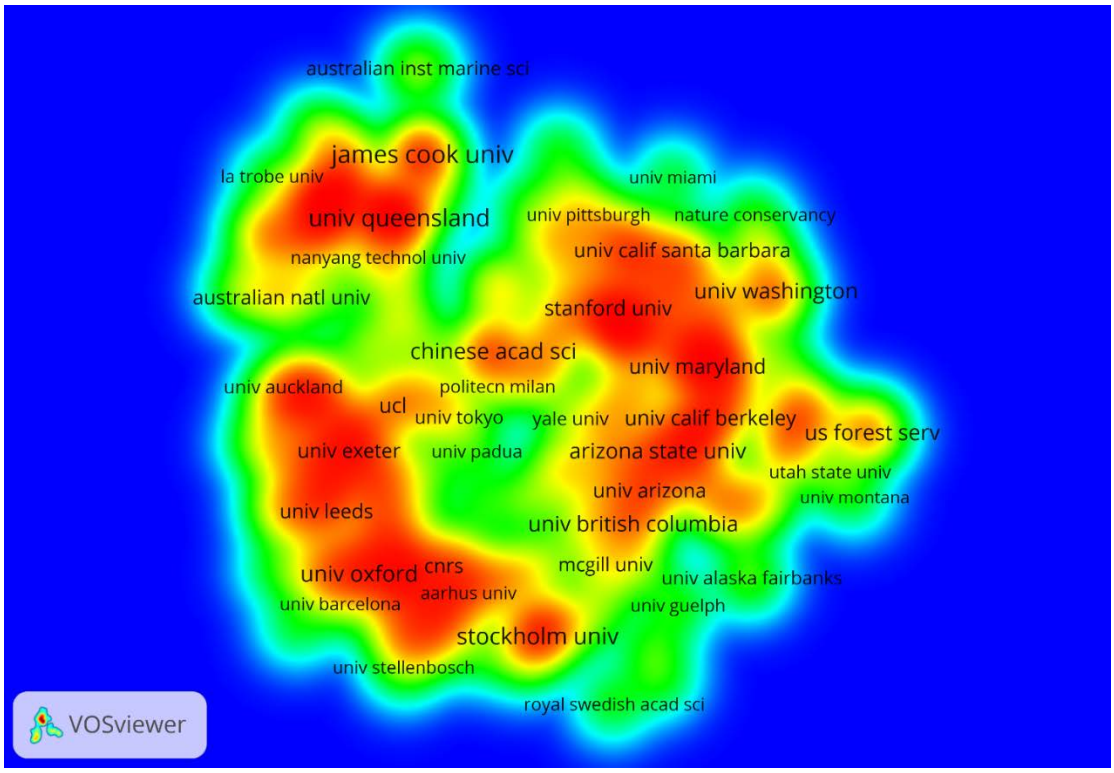

Fig. 90 Resilience bibliographic coupling by organization

Search Term: Risk AND Sustainability 1990-2017

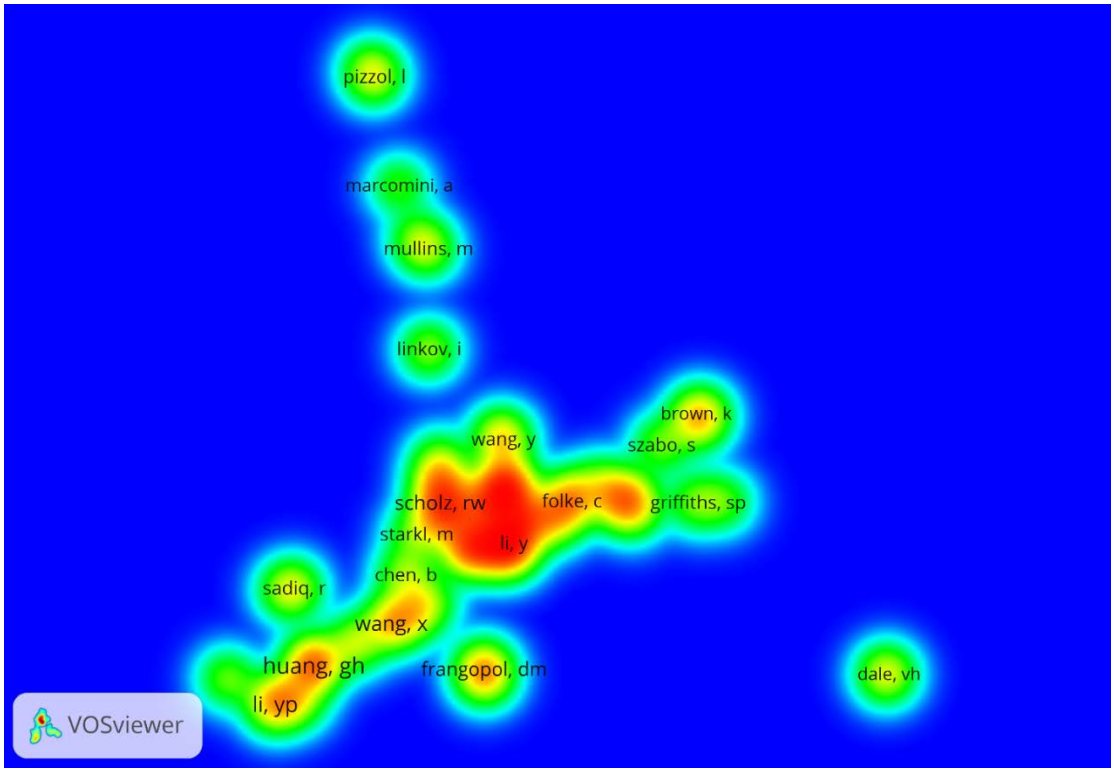

Fig. 91 Risk AND Sustainability bibliographic coupling by author

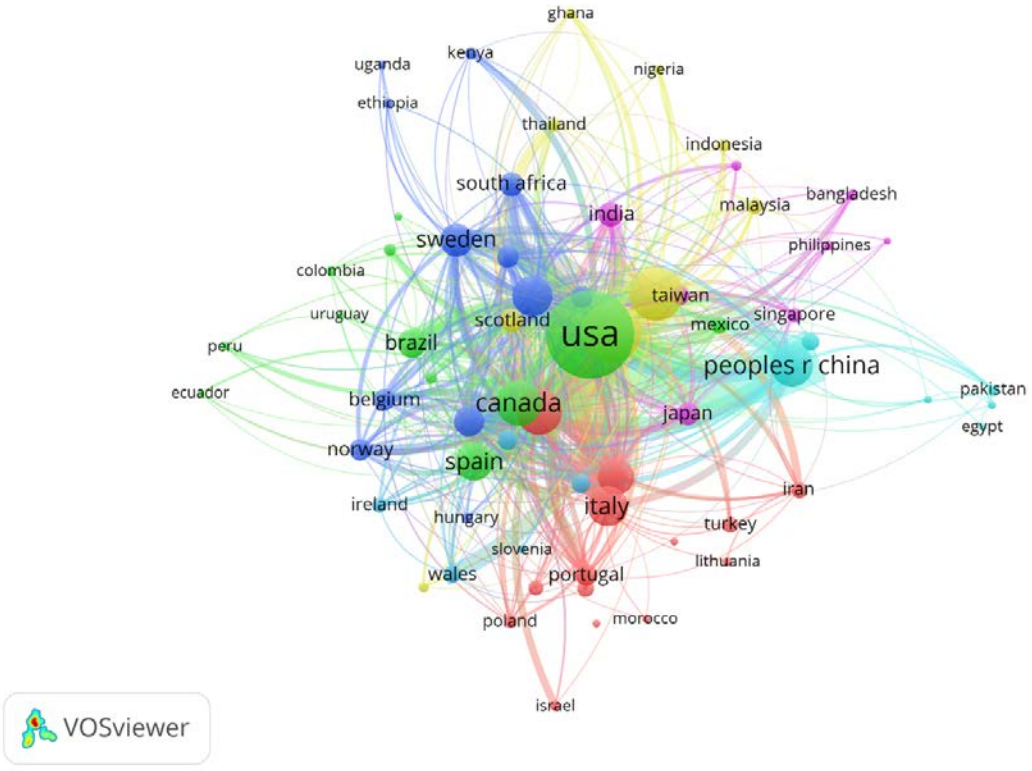

Fig. 92 Risk AND Sustainability bibliographic coupling by country

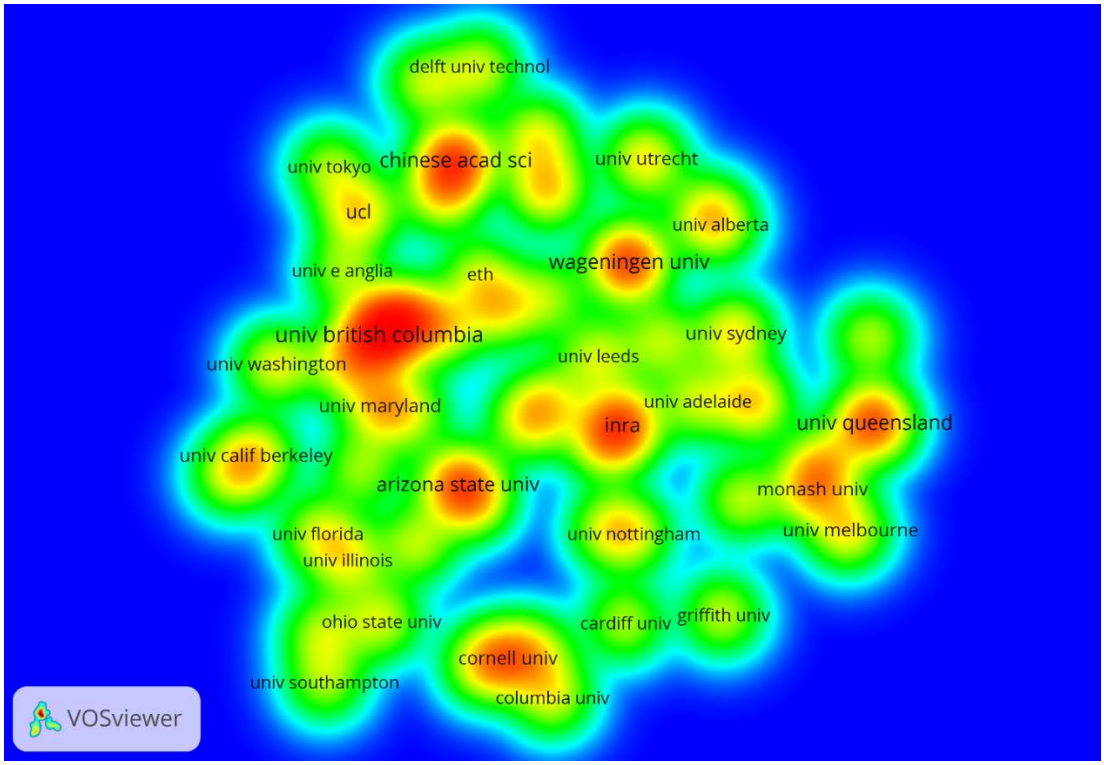

Fig. 93 Risk AND Sustainability bibliographic coupling by organization

Search Term: Risk AND Resilience 1990-2017

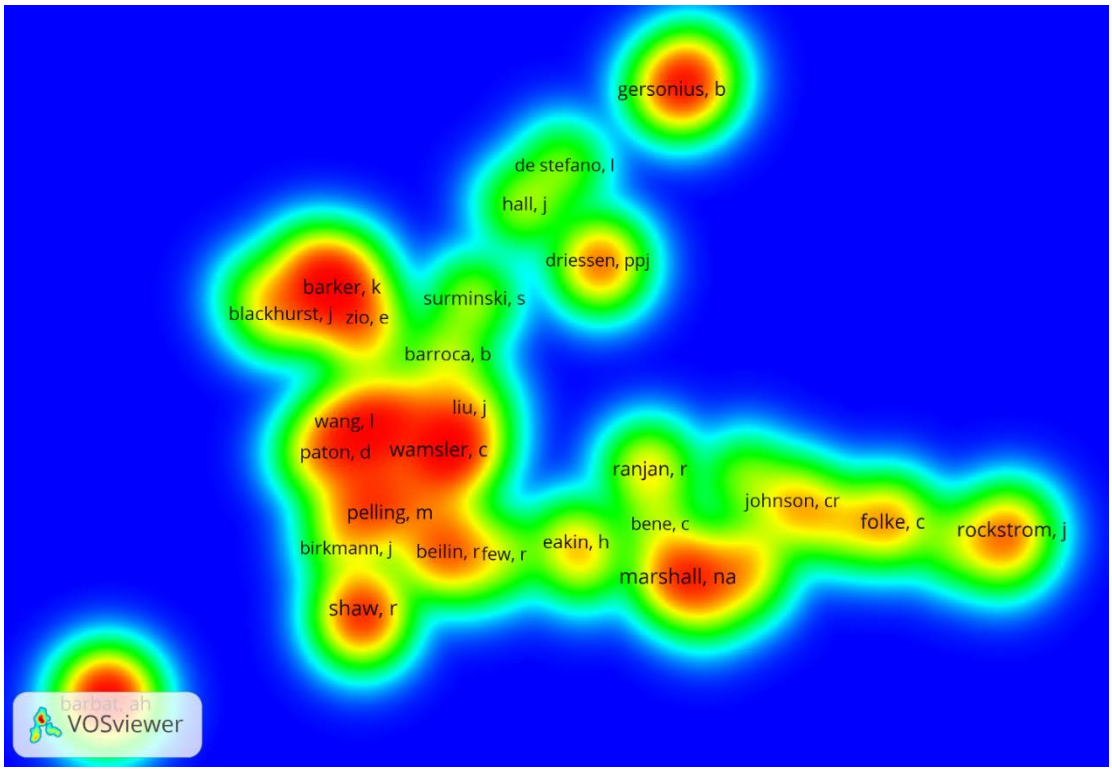

Fig. 94 Risk AND Resilience bibliographic coupling by author

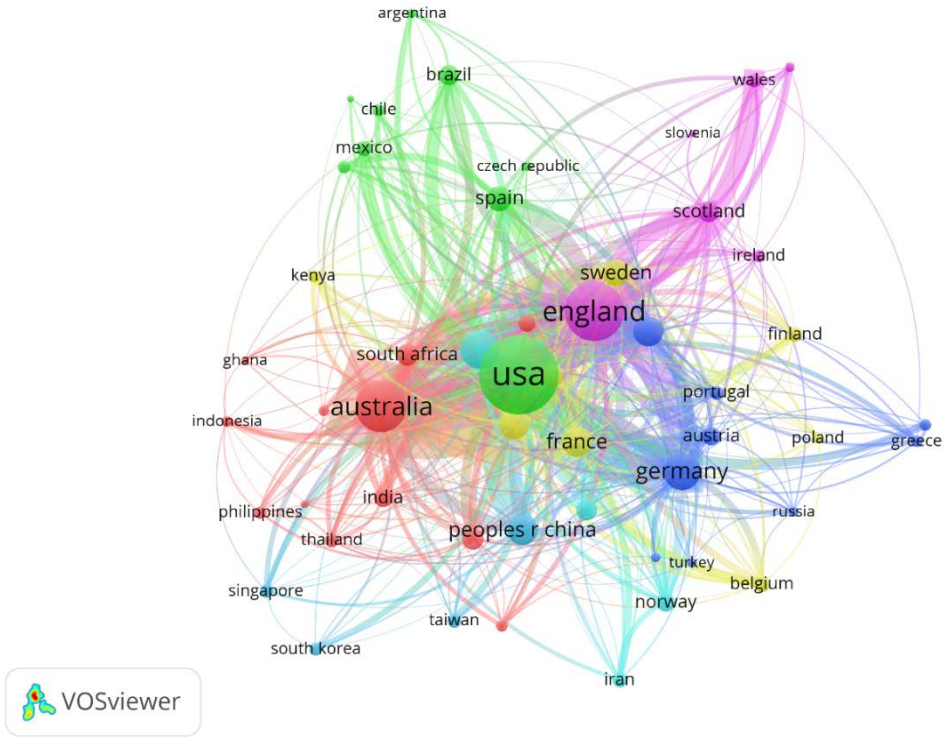

Fig. 95 Risk AND Resilience bibliographic coupling by country

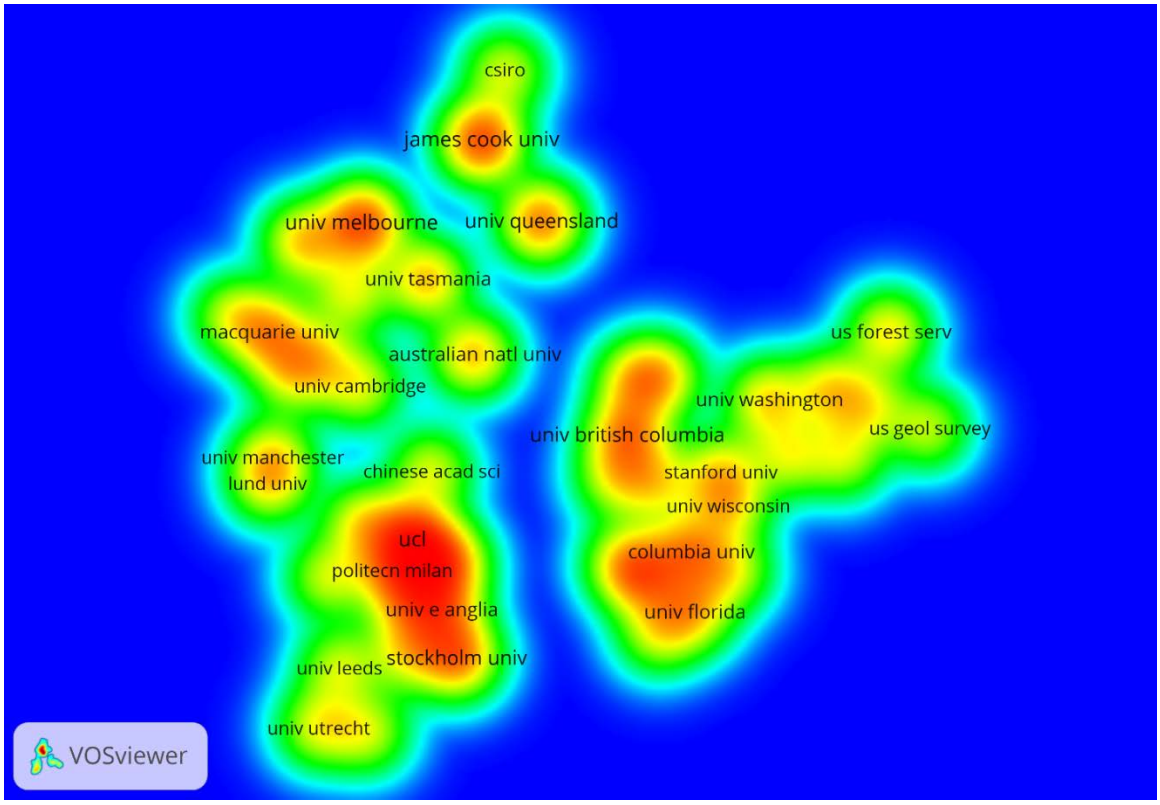

Fig. 96 Risk AND Resilience bibliographic coupling by organization

Search Term: Risk AND Sustainability AND Resilience 1990-2017

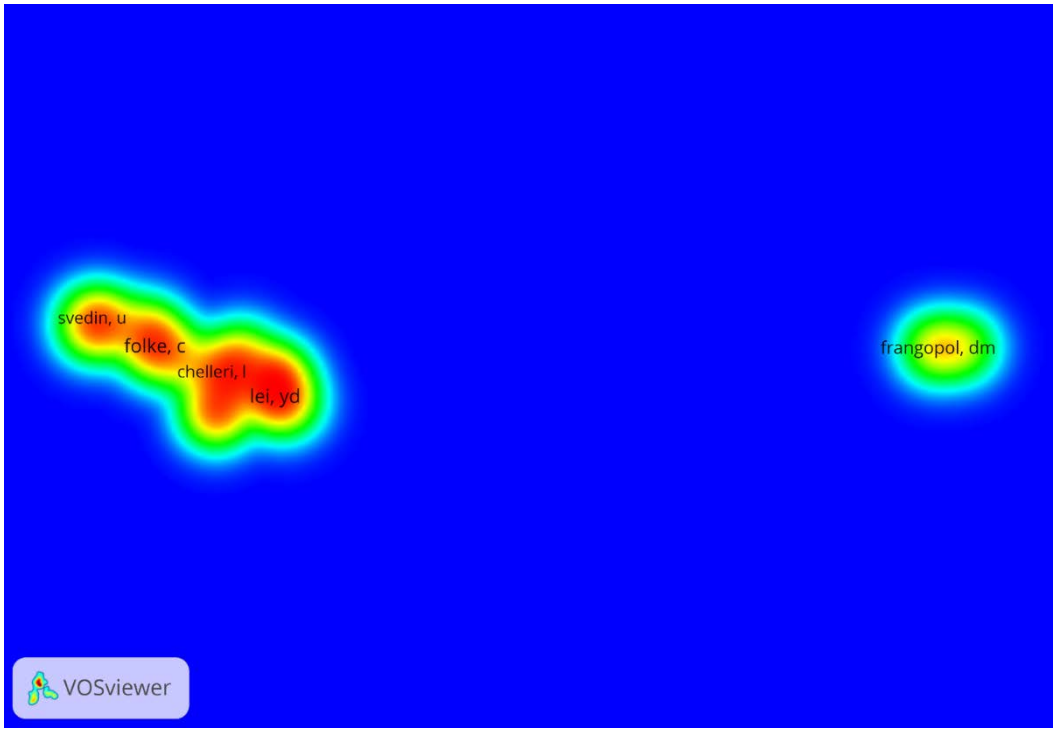

Fig. 97 Risk AND Sustainability AND Resilience bibliographic coupling by author

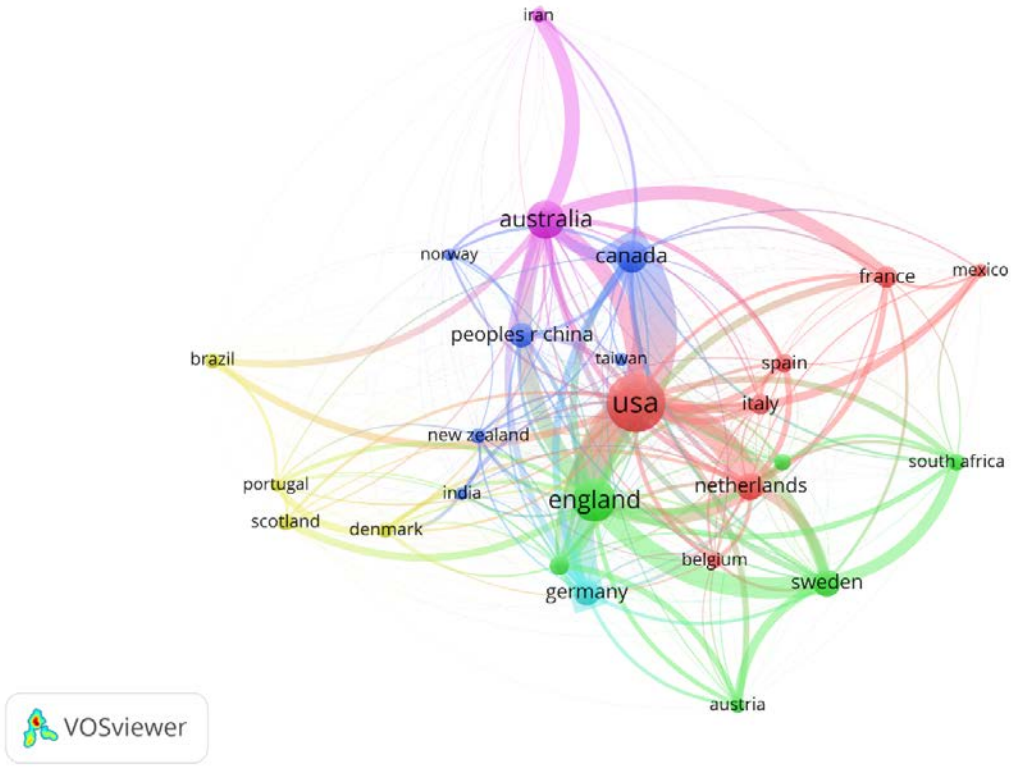

Fig. 98 Risk AND Sustainability AND Resilience bibliographic coupling by country

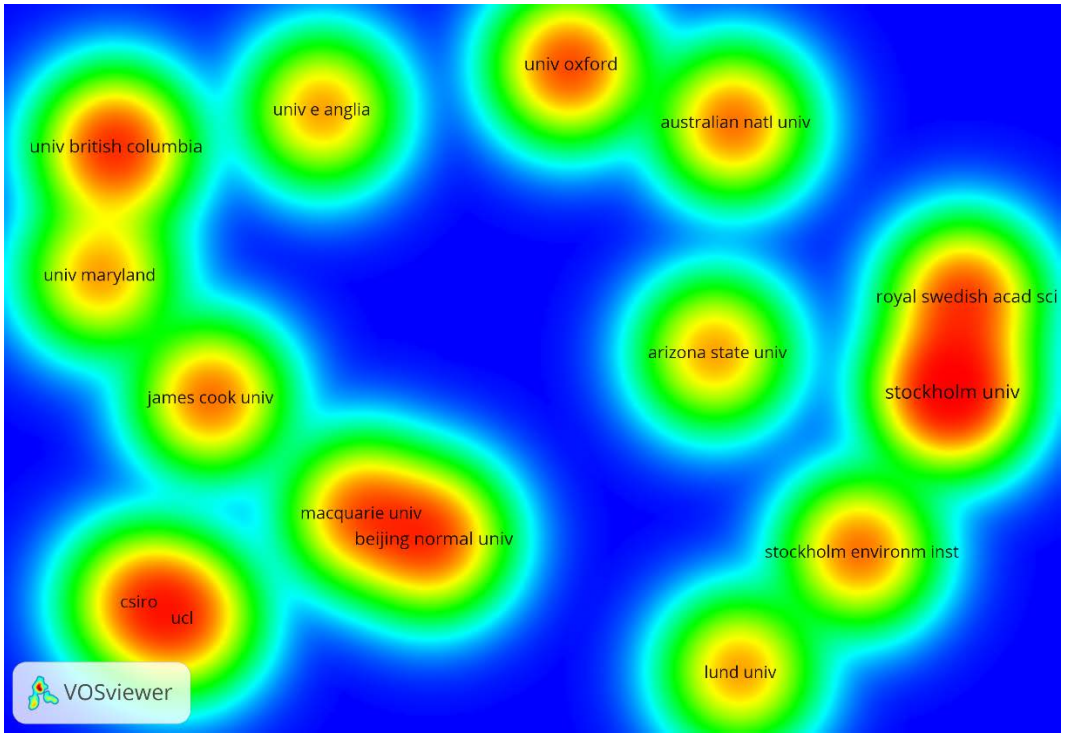

Fig. 99 Risk AND Sustainability AND Resilience bibliographic coupling by organization

3.3 Detailed Group 2 Search terms for bibliographic coupling network analysis

Search Term: Ecological Resilience 1990-2017

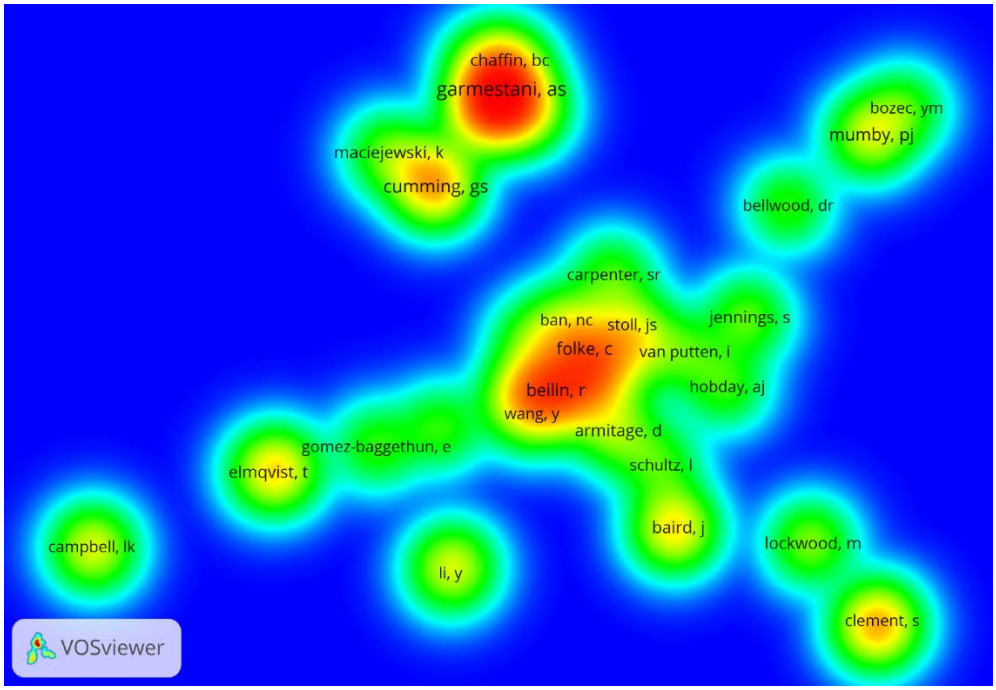

Fig. 100 Ecological resilience bibliographic coupling by author

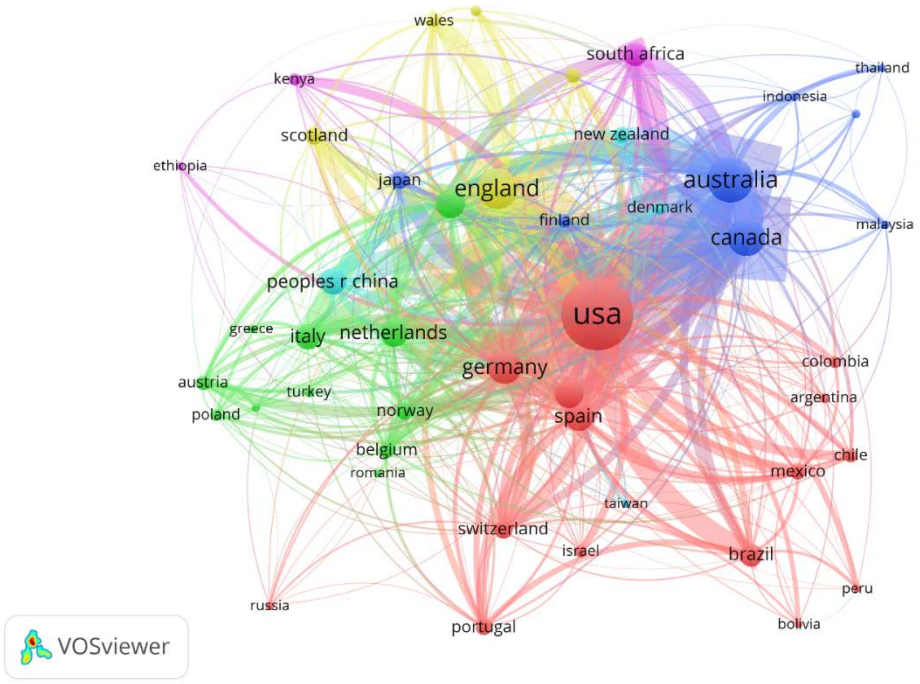

Fig. 101 Ecological resilience bibliographic coupling by country

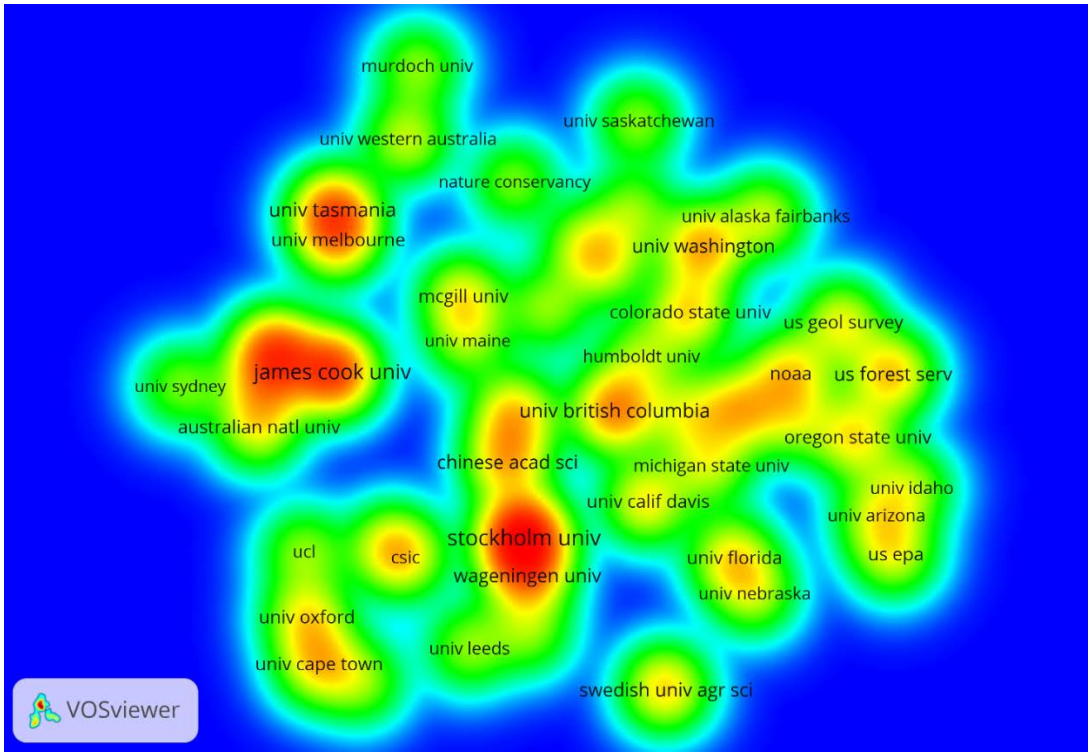

Fig. 102 Ecological resilience bibliographic coupling by organization

Search Term: Spatial Resilience 1990-2017

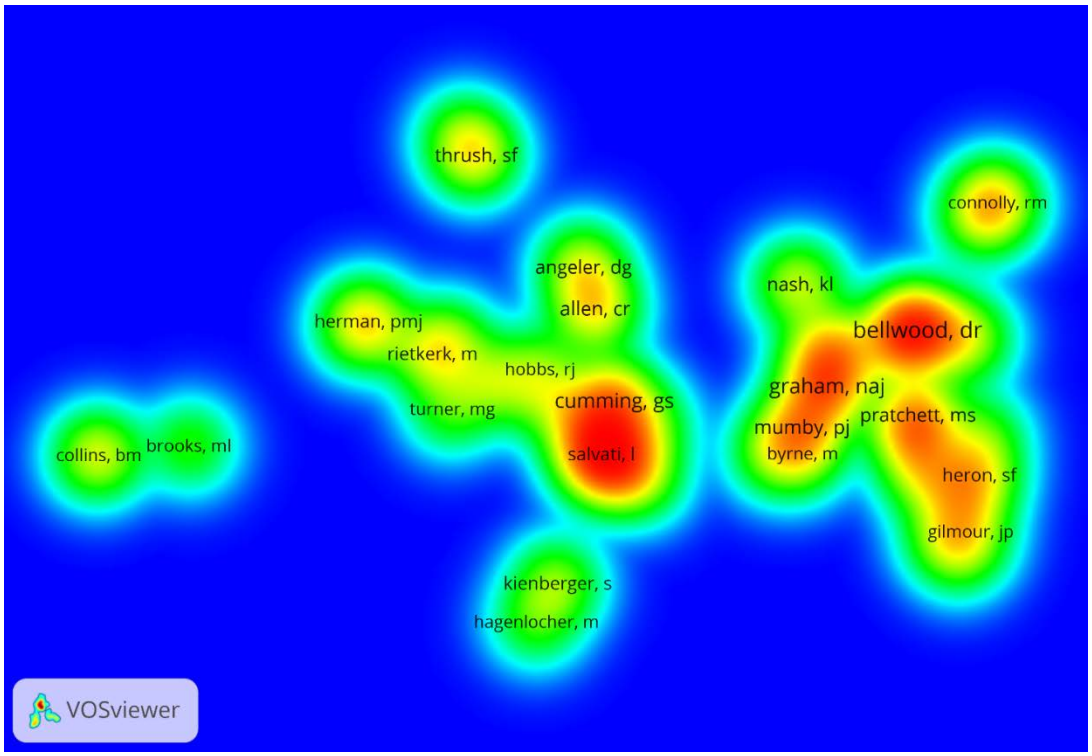

Fig. 103 Spatial Resilience bibliographic coupling by author

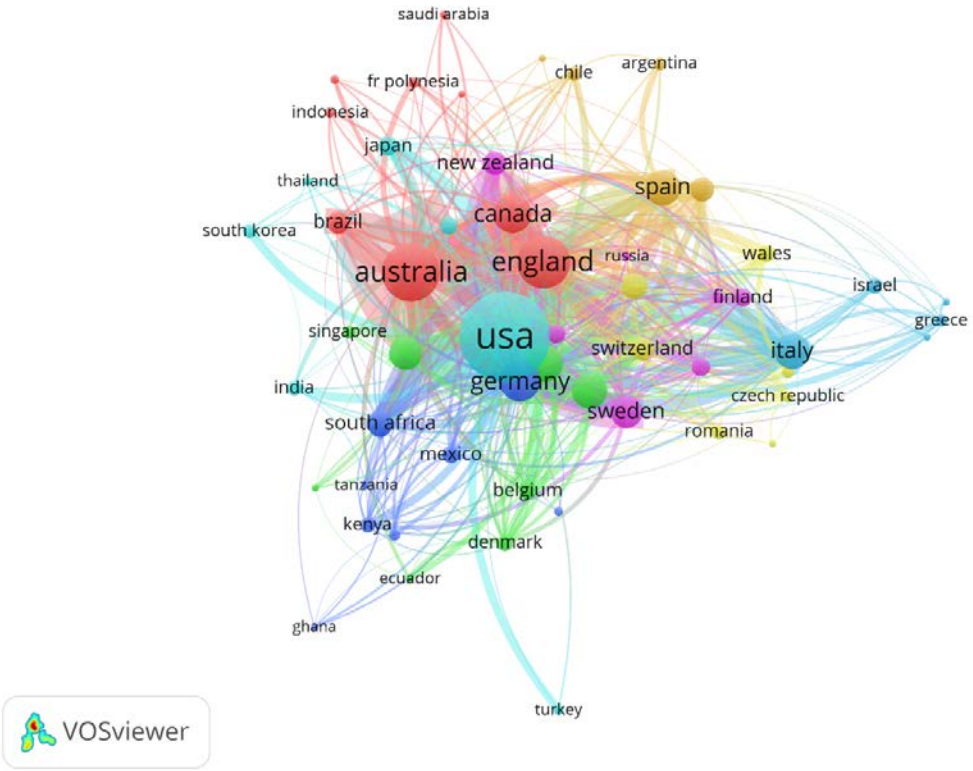

Fig. 104 Spatial Resilience bibliographic coupling by country

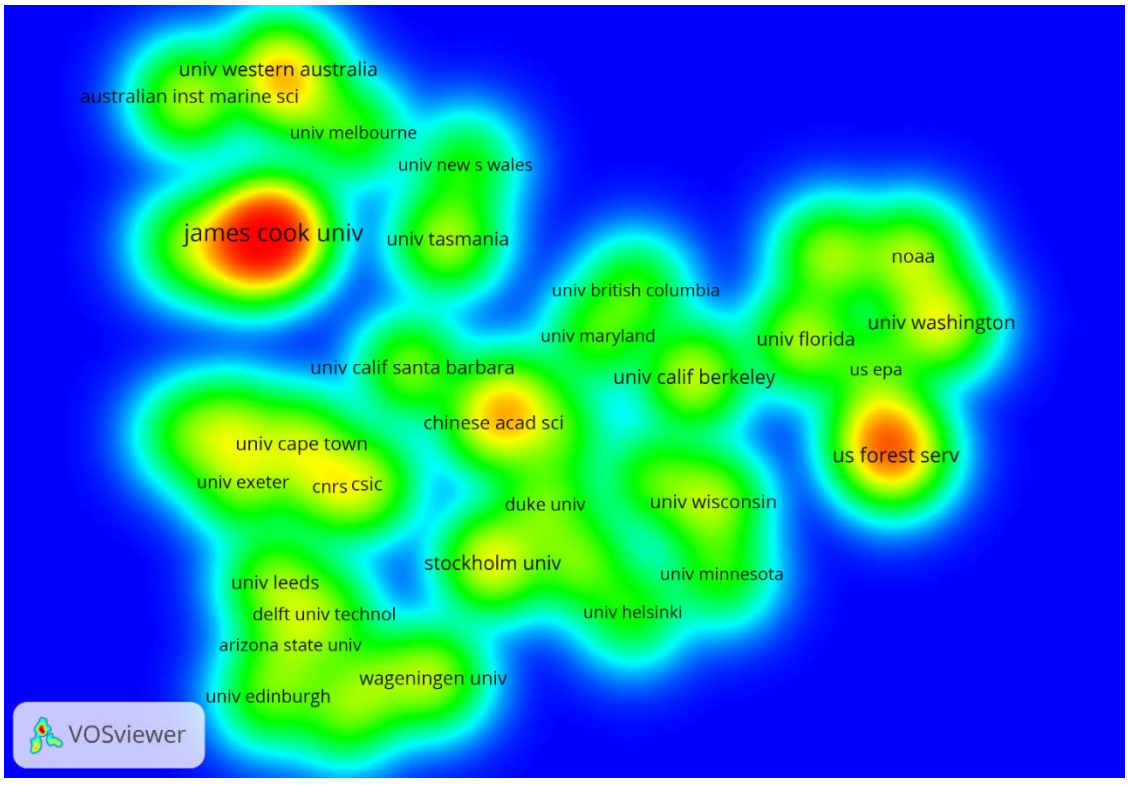

Fig. 105 Spatial Resilience bibliographic coupling by organization

Search Term: Engineering Resilience 1990-2017

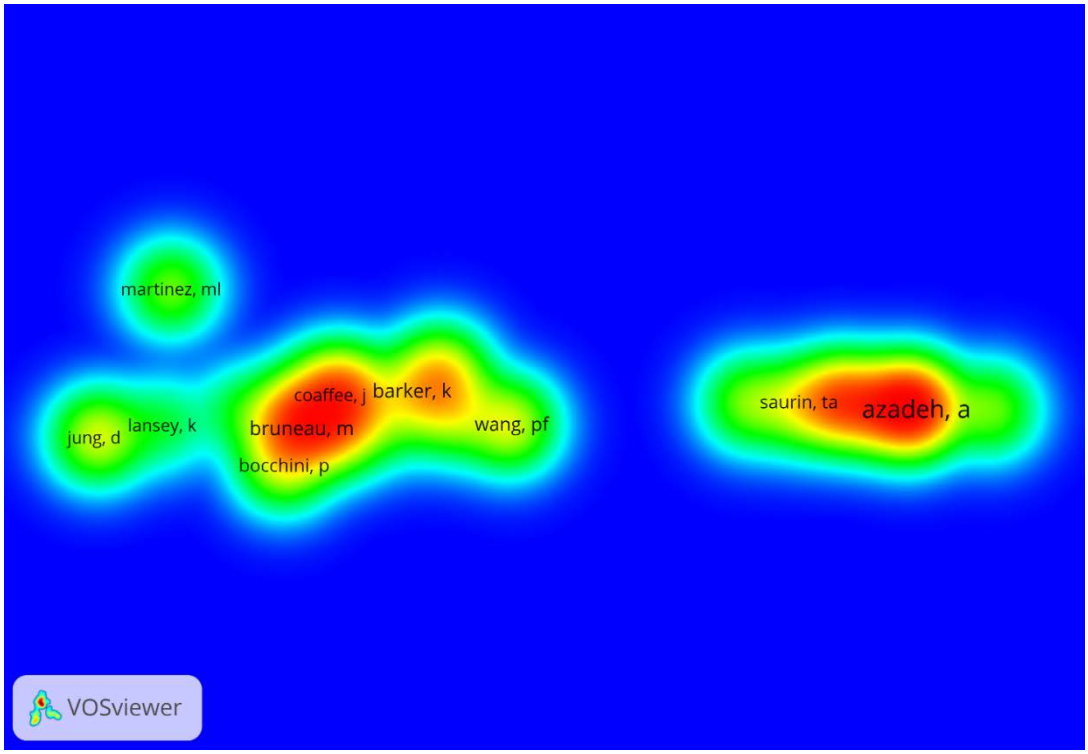

Fig. 106 Engineering resilience bibliographic coupling by author

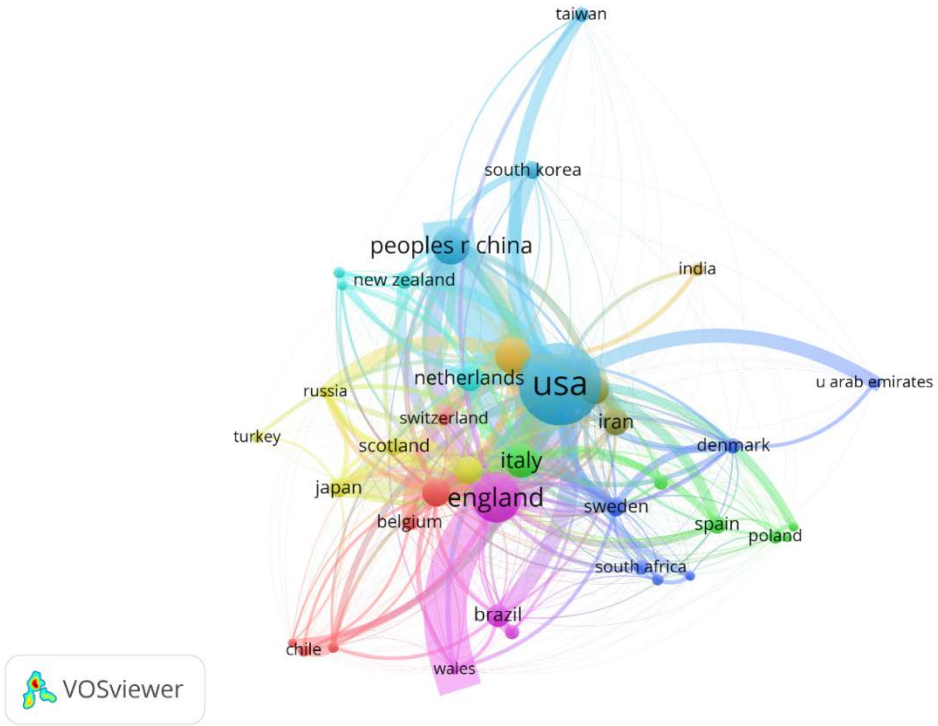

Fig. 107 Engineering resilience bibliographic coupling by country

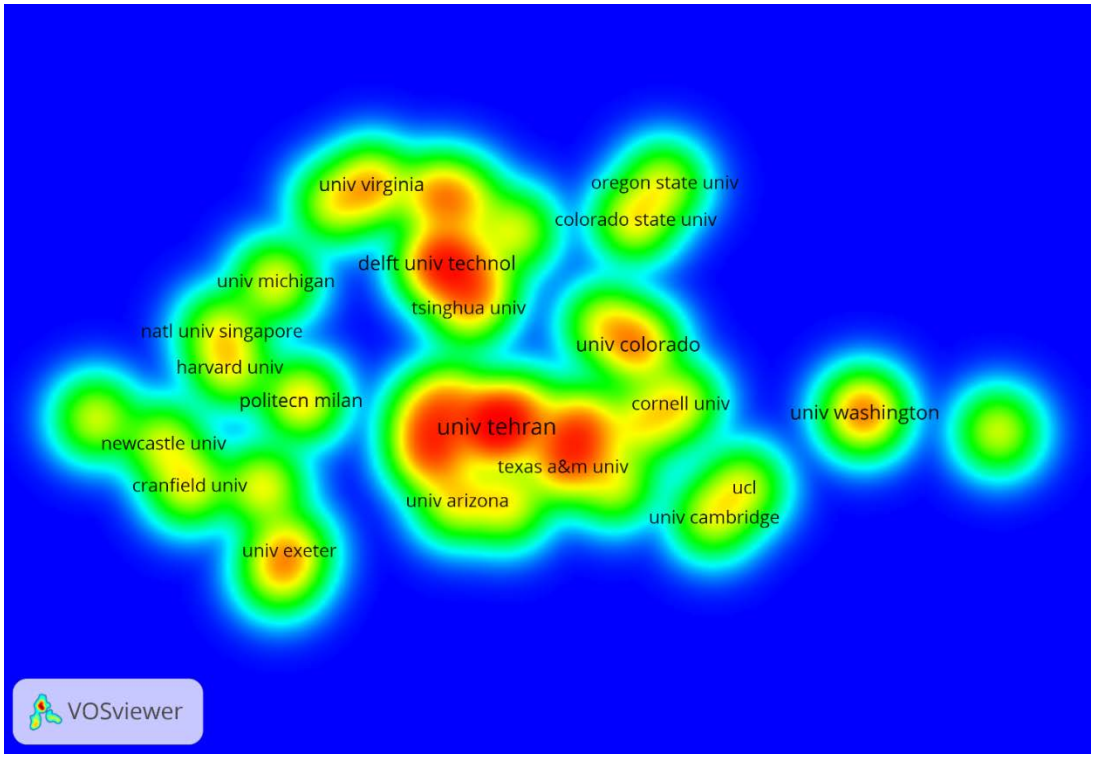

Fig. 108 Engineering resilience bibliographic coupling by organization

Search Term: Infrastructure Resilience 1990-2017

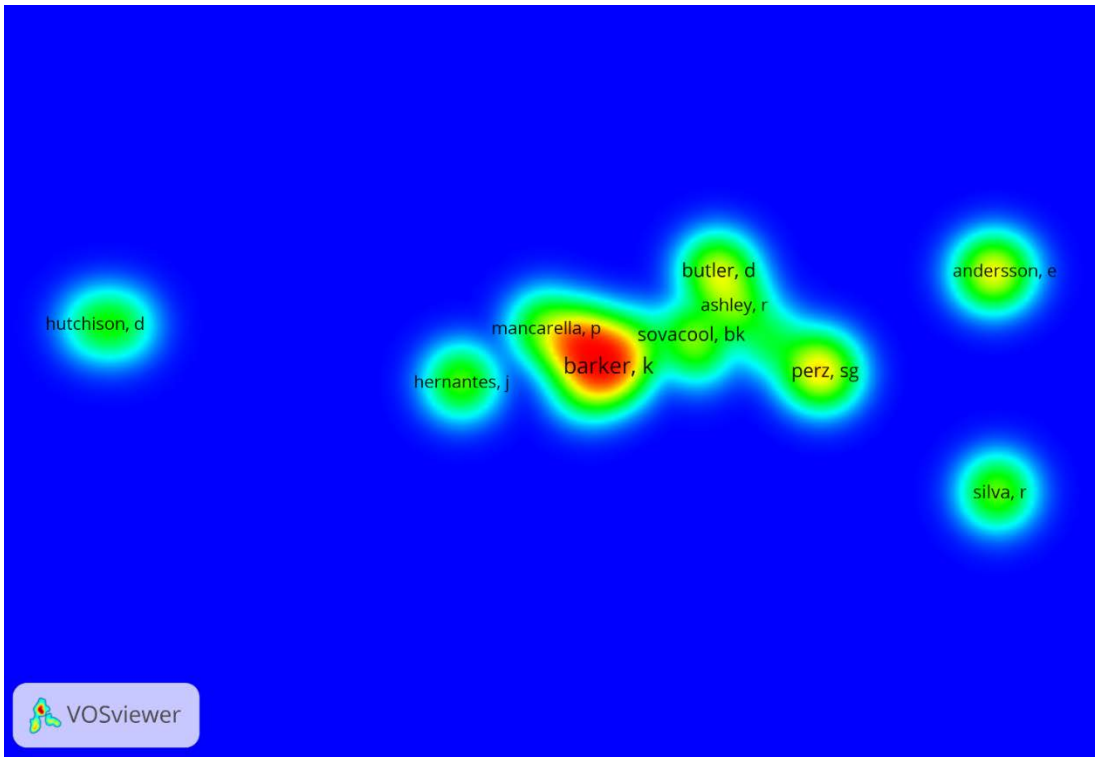

Fig. 109 Infrastructure Resilience bibliographic coupling by author

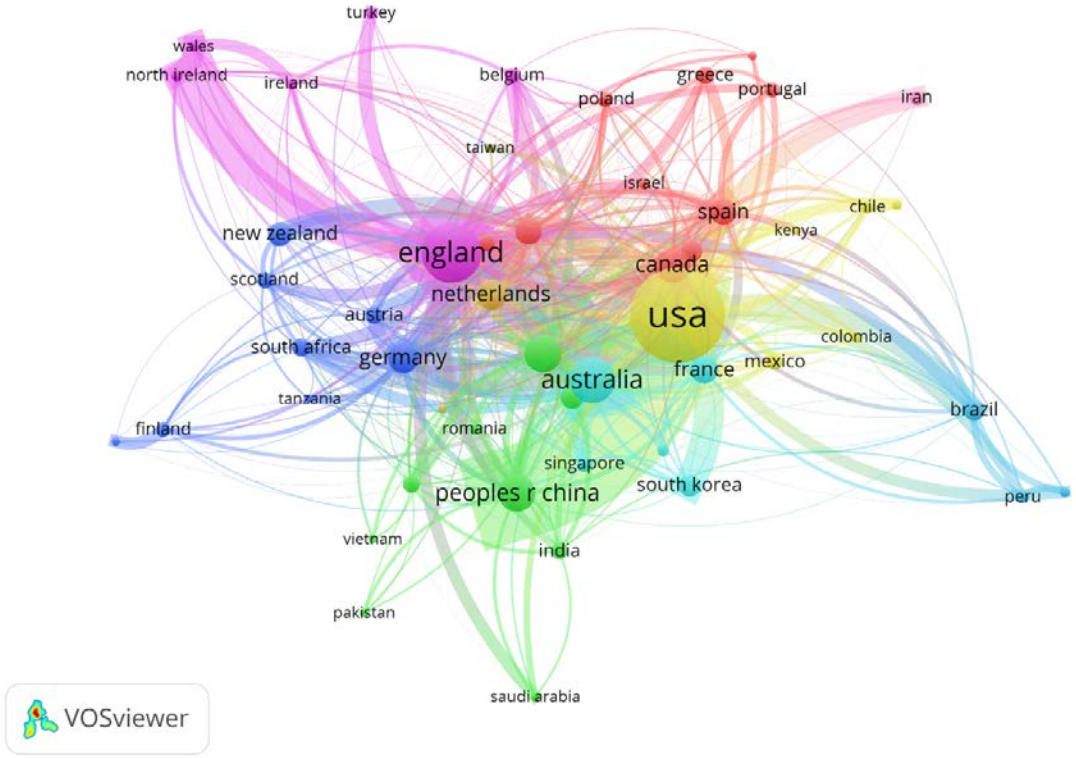

Fig. 110 Infrastructure Resilience bibliographic coupling by country

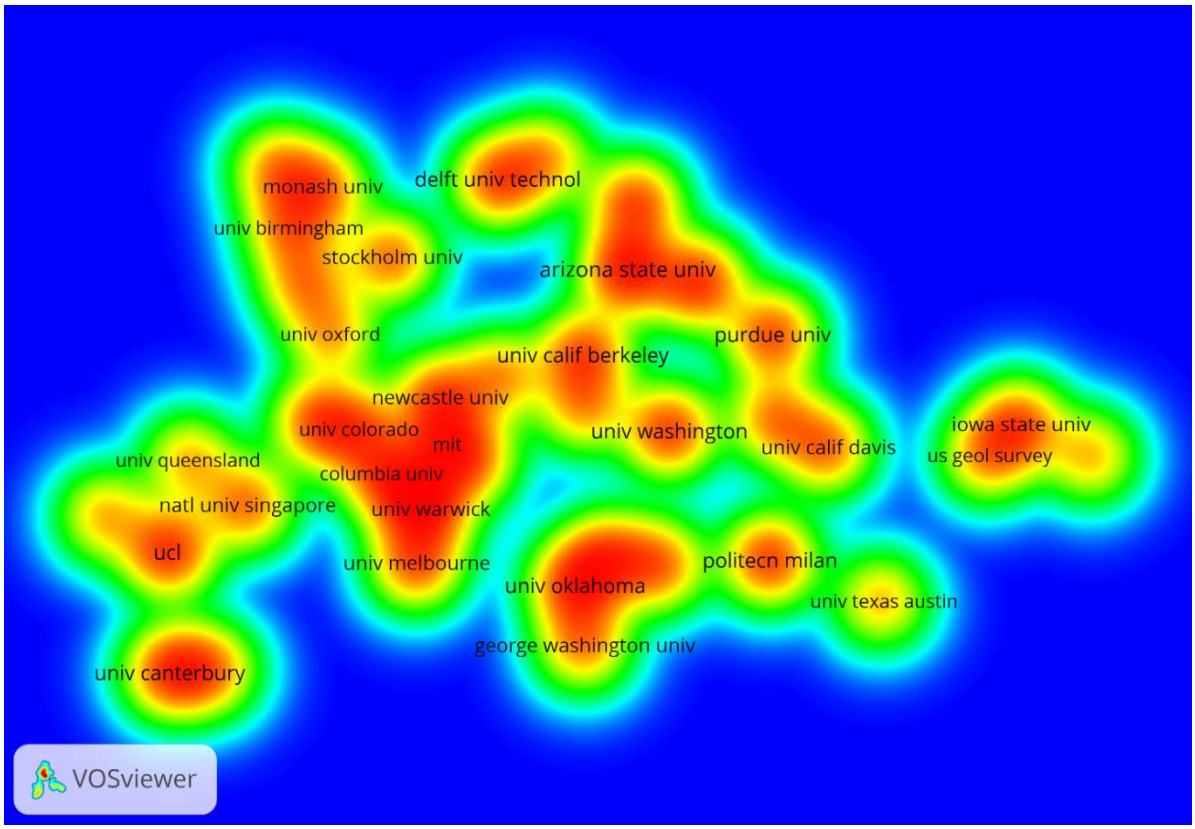

Fig. 111 Infrastructure Resilience bibliographic coupling by organization

Search Term: Robustness 1990-2017

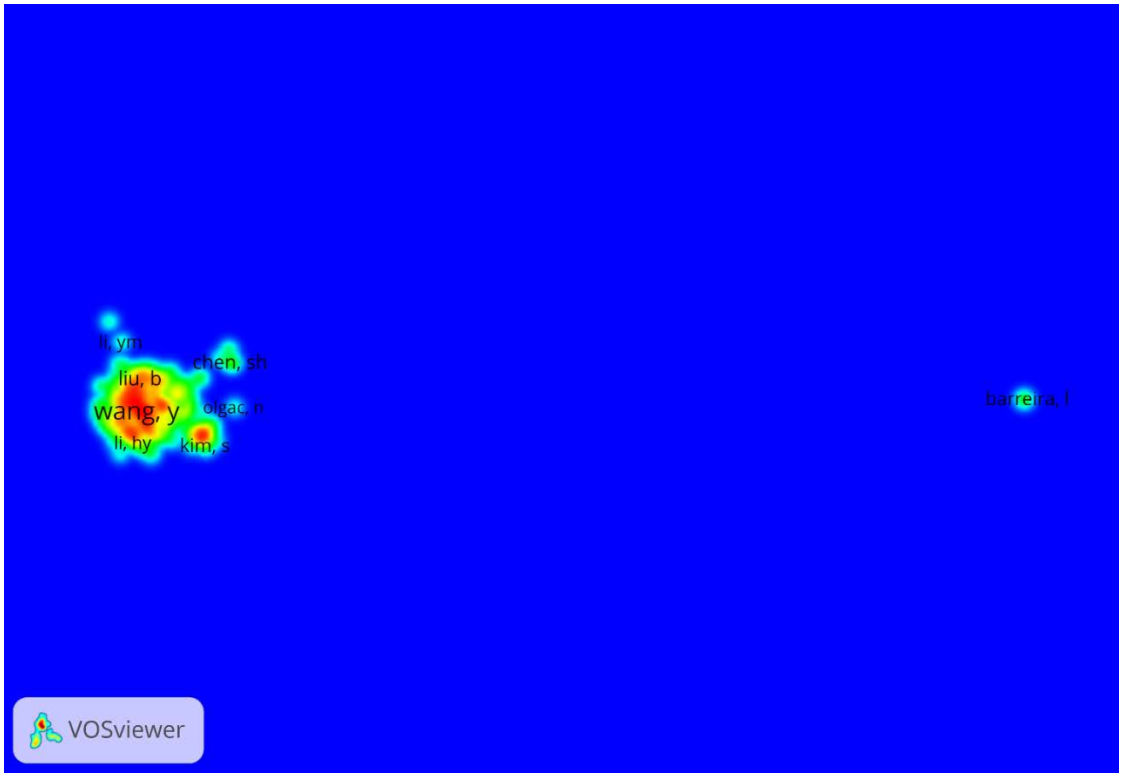

Fig. 112 Robustness bibliographic coupling by author

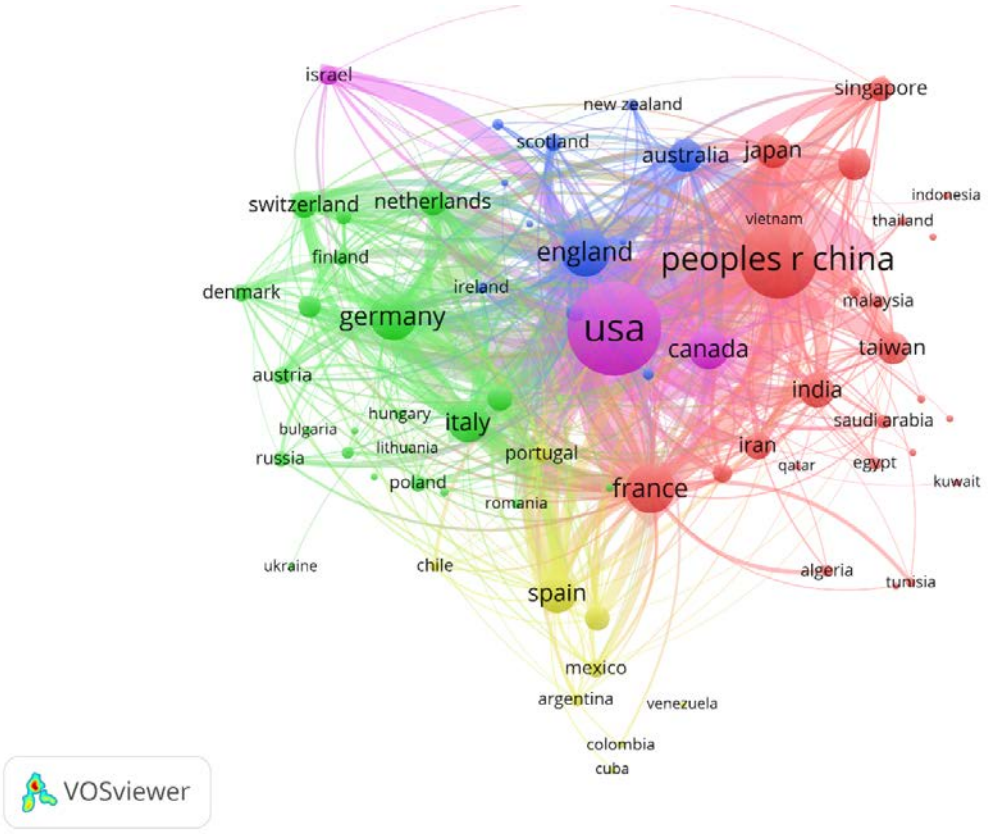

Fig. 113 Robustness bibliographic coupling by country

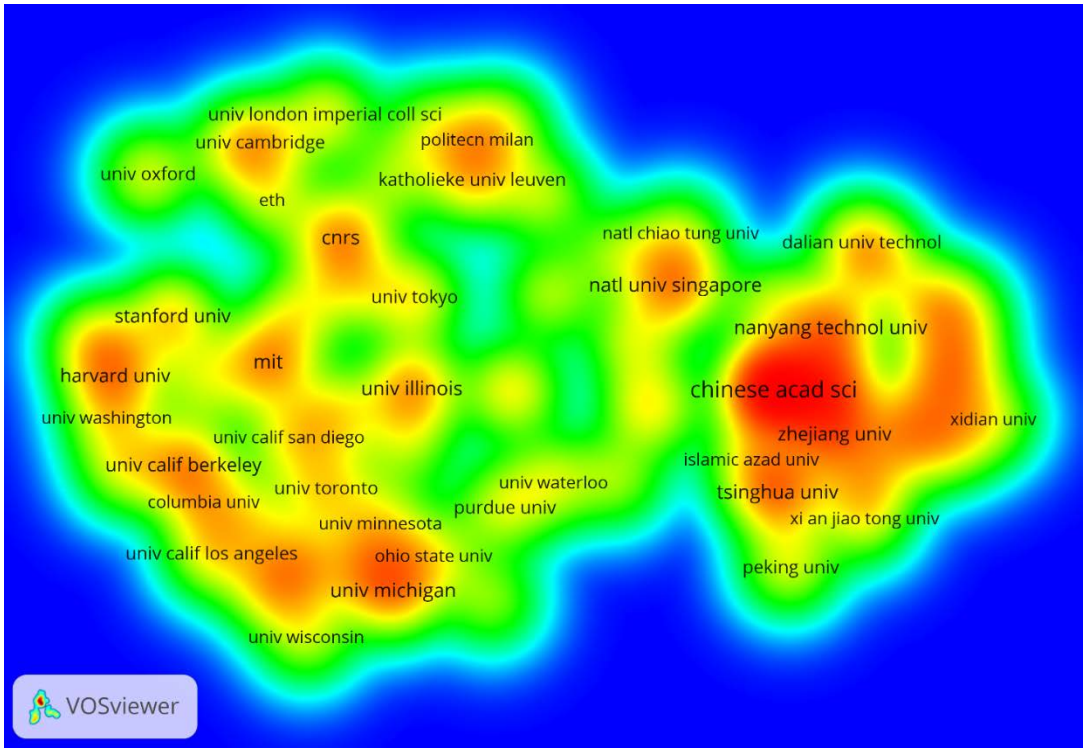

Fig. 114 Robustness bibliographic coupling by organization

Search Term: Disaster Resilience 1990-2017

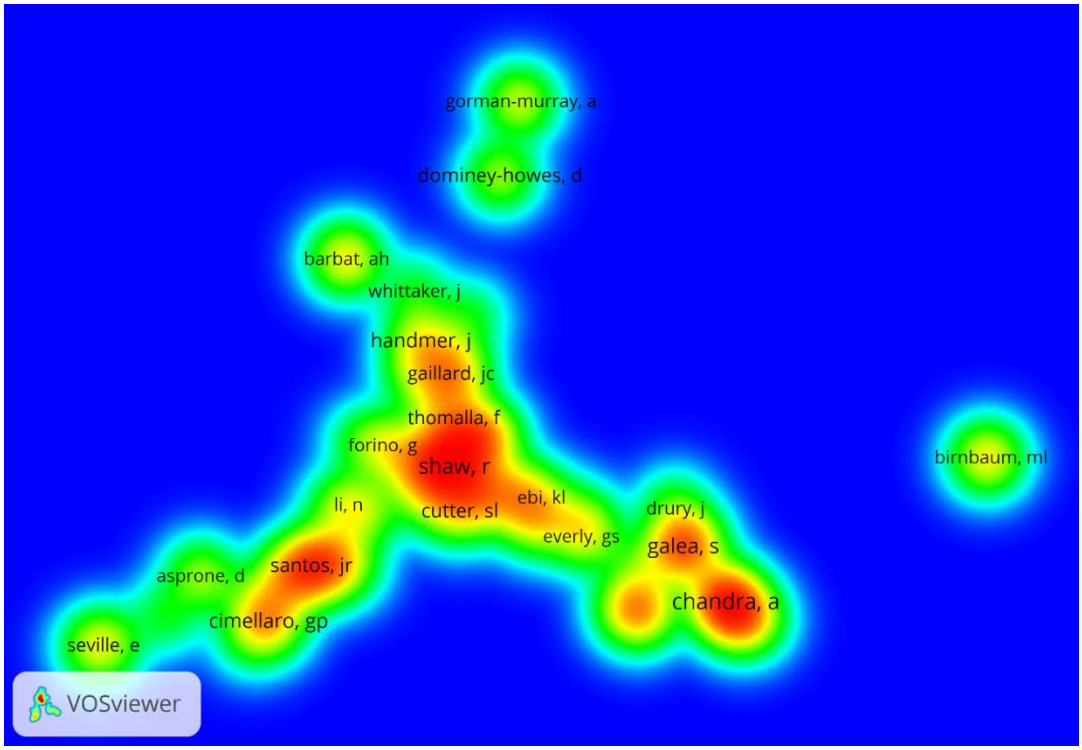

Fig. 115 Disaster resilience bibliographic coupling by author

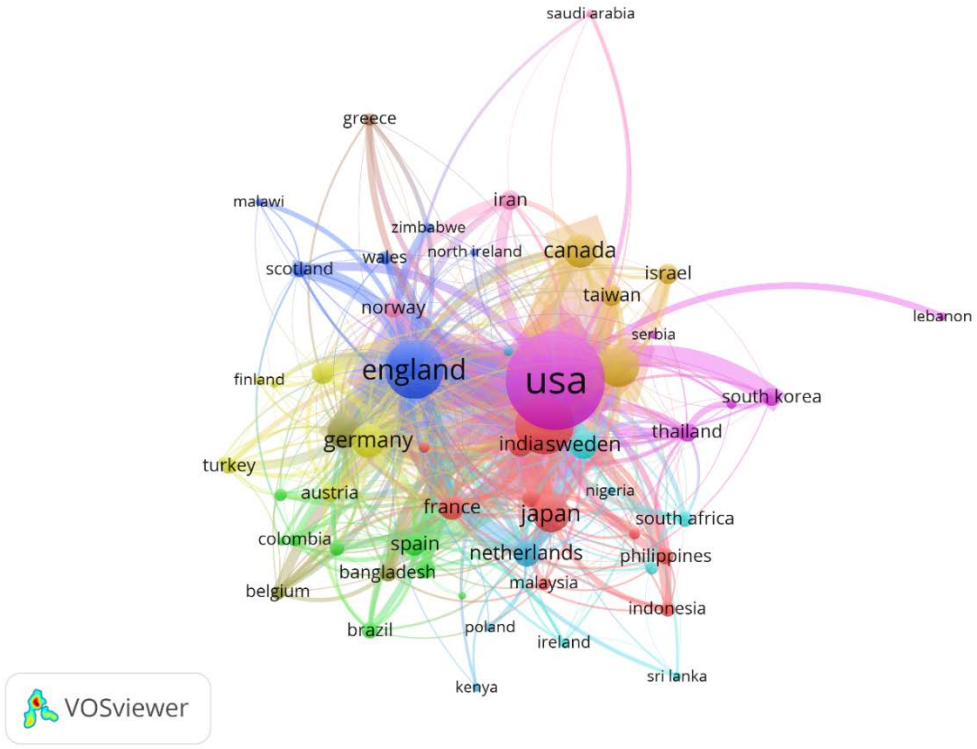

Fig. 116 Disaster resilience bibliographic coupling by country

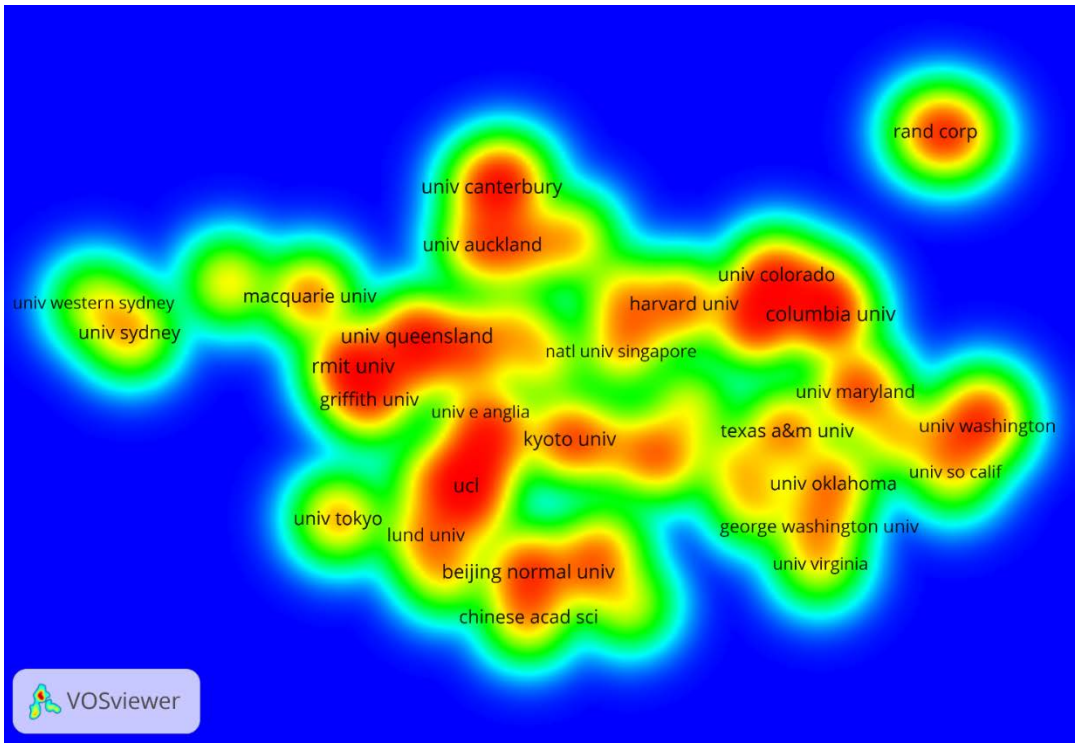

Fig. 117 Disaster resilience bibliographic coupling by organization

Search Term: Community Resilience 1990-2017

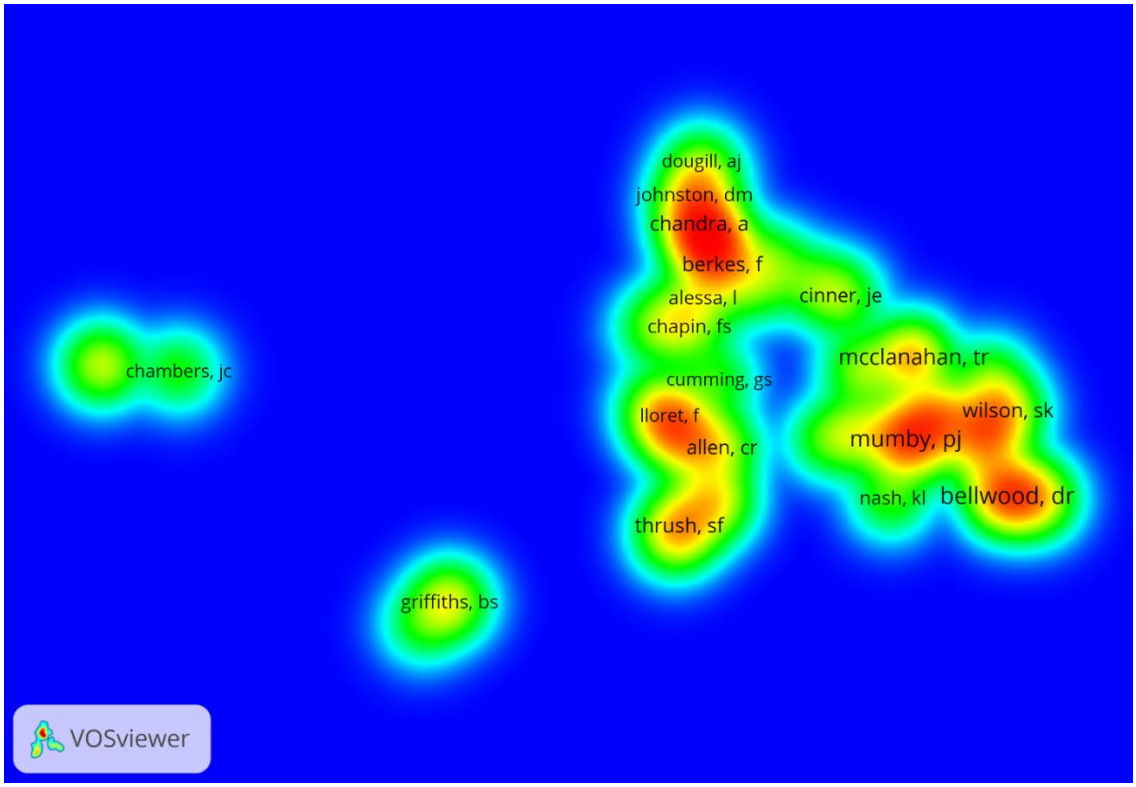

Fig. 118 Community Resilience bibliographic coupling by author

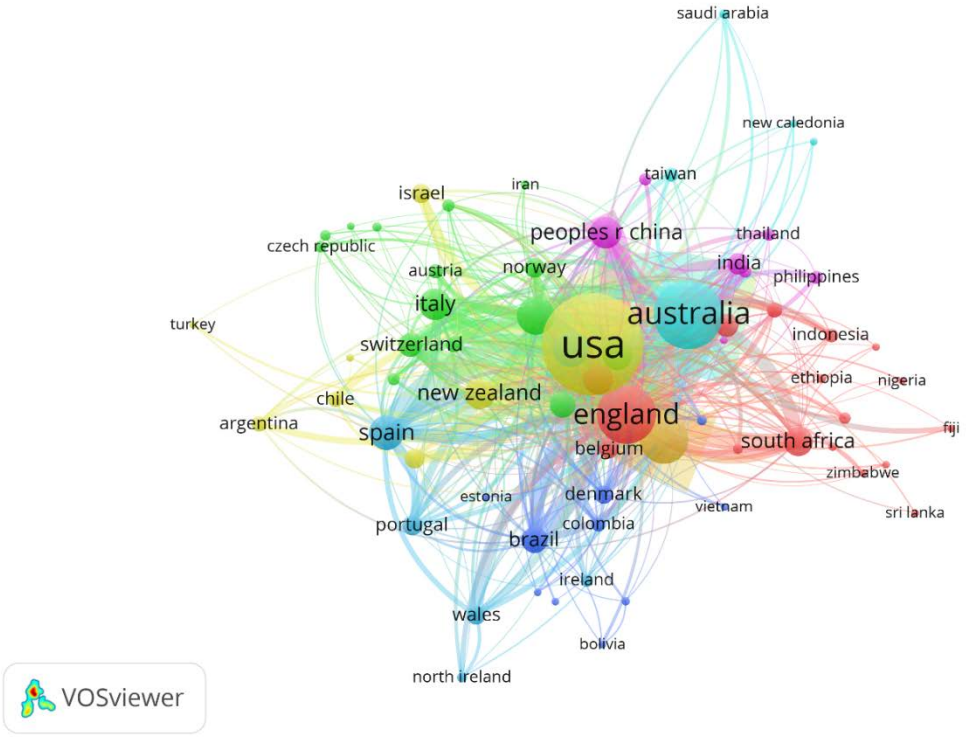

Fig. 119 Community Resilience bibliographic coupling by country

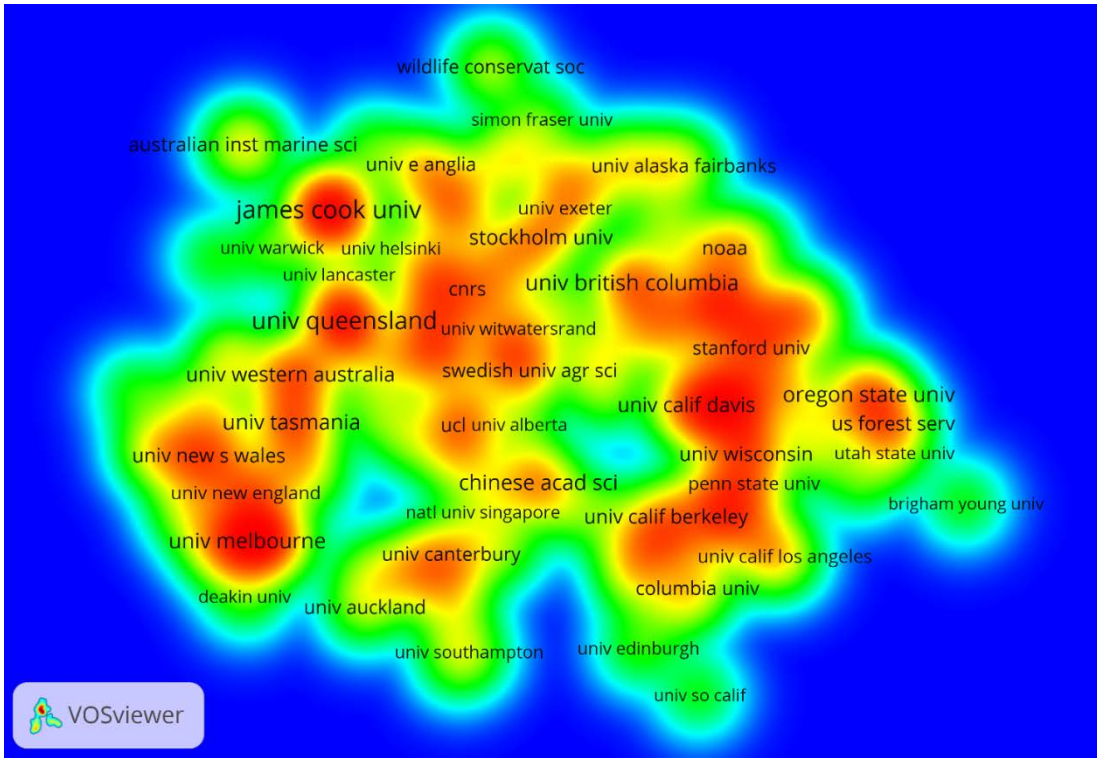

Fig. 120 Community Resilience bibliographic coupling by organization

Search Term: Urban Resilience 1990-2017

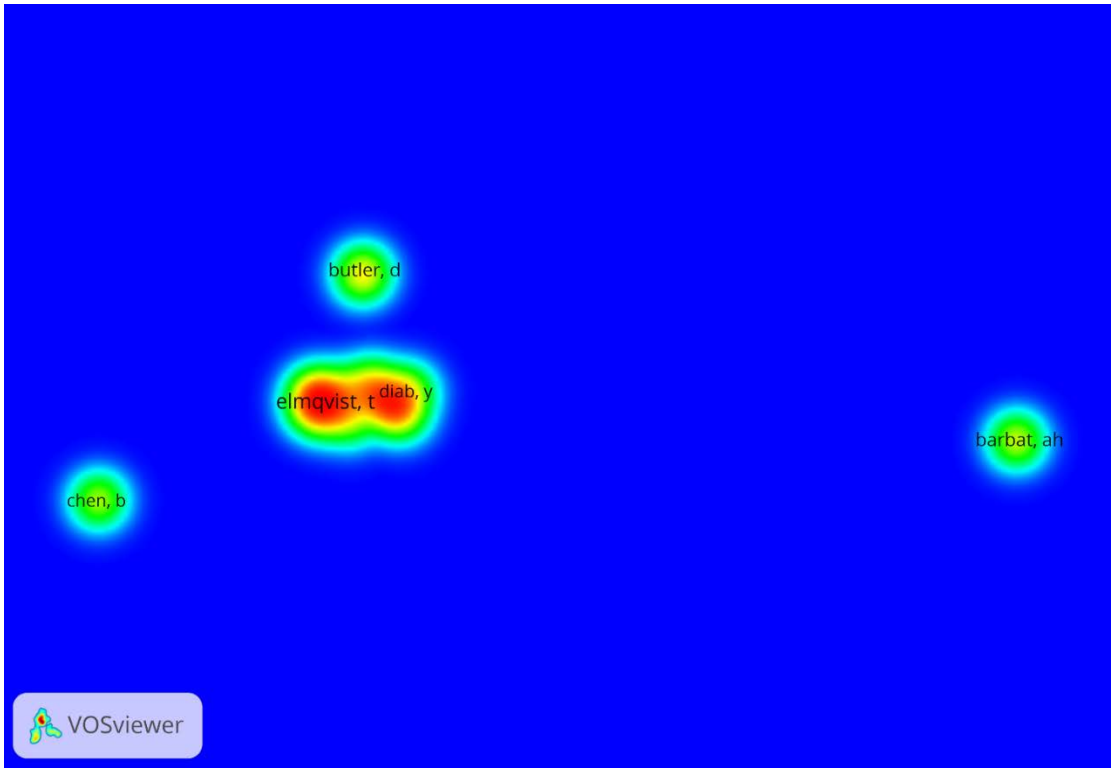

Fig. 121 Urban Resilience bibliographic coupling by author

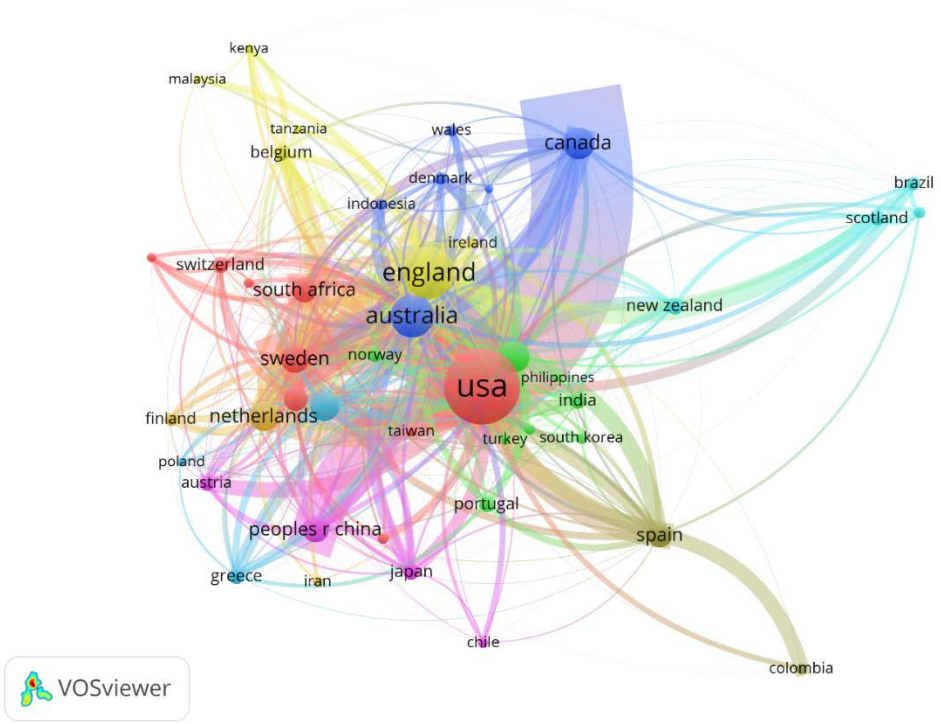

Fig. 122 Urban Resilience bibliographic coupling by country

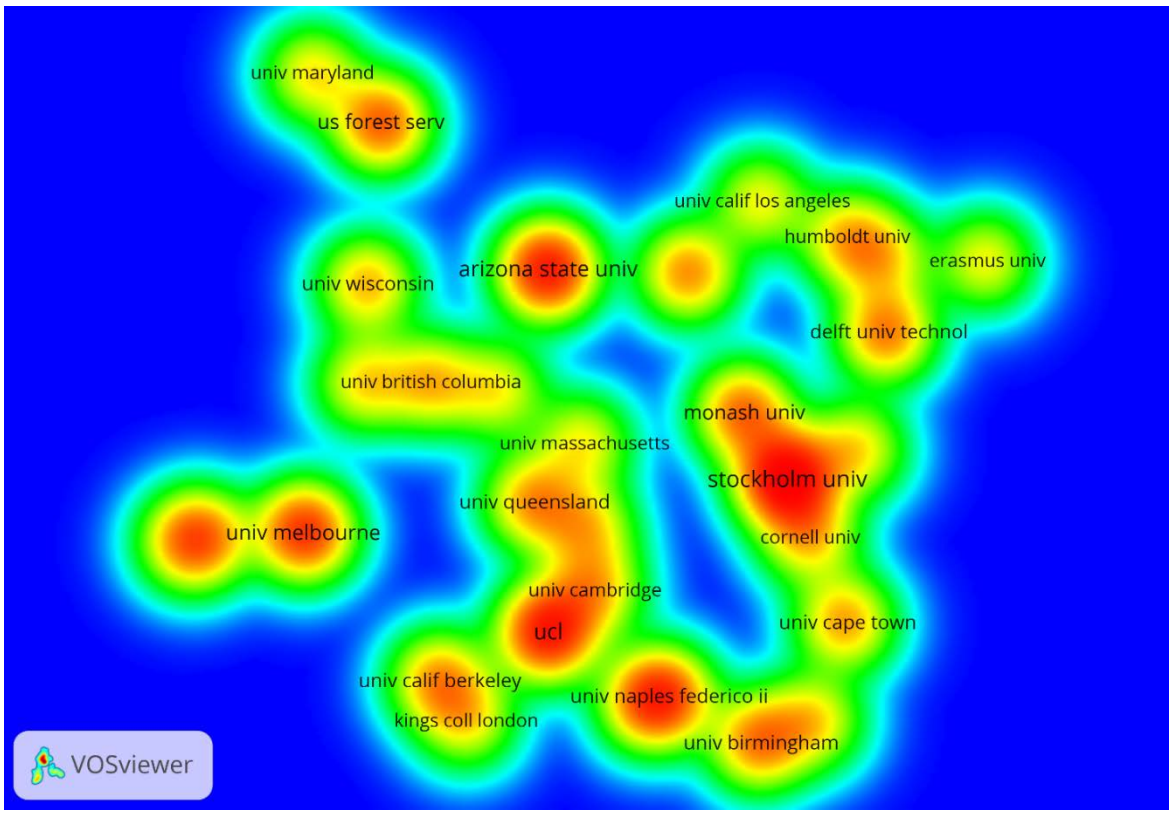

Fig. 123 Urban Resilience bibliographic coupling by organization

Search Term: (Economic) Development Resilience 1990-2017

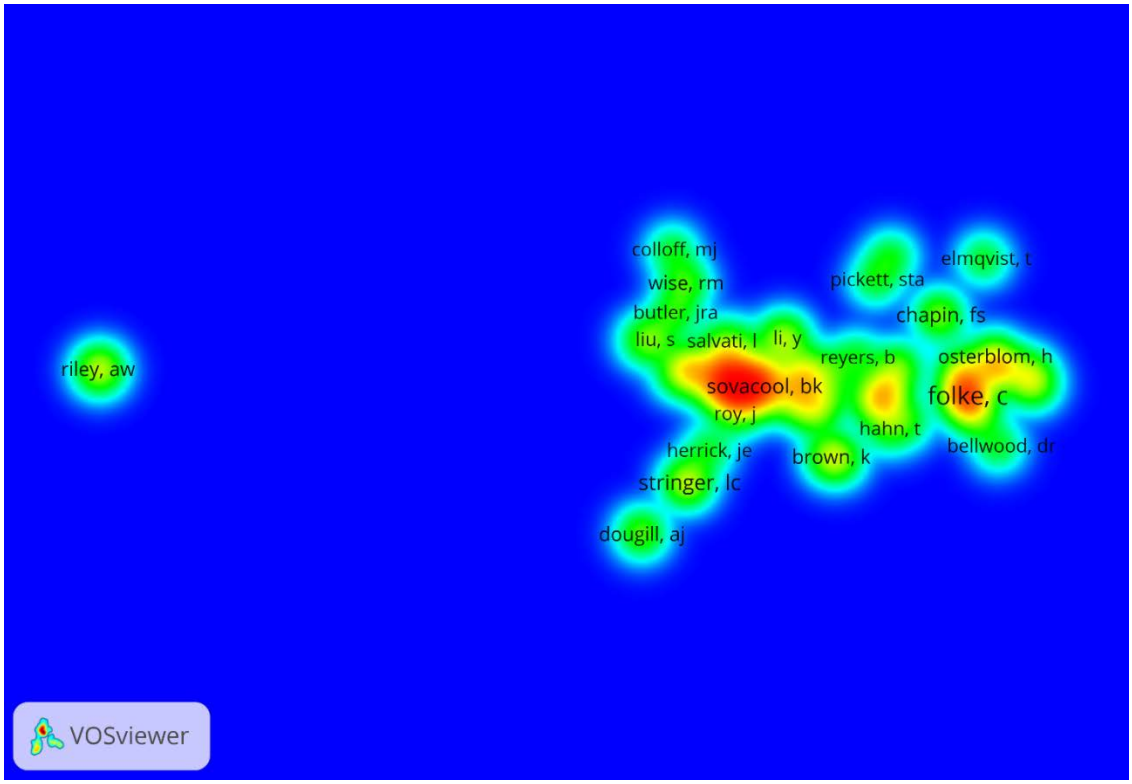

Fig. 124 (Economic) Development Resilience bibliographic coupling by author

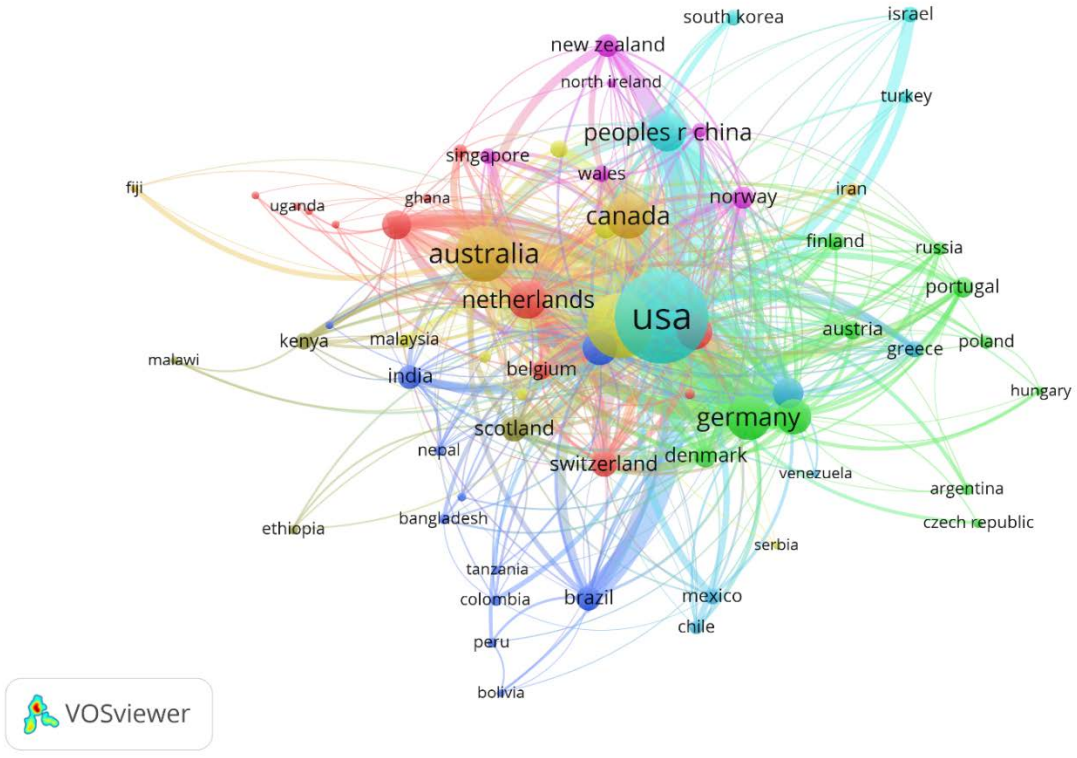

Fig. 125 (Economic) Development Resilience bibliographic coupling by country

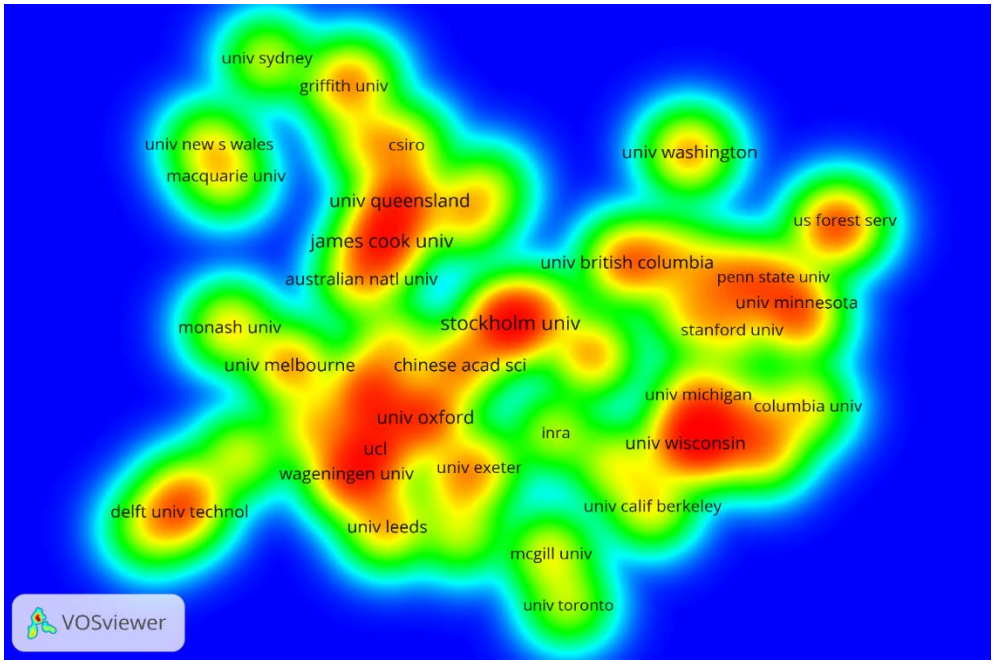

Fig. 126 (Economic) Development Resilience bibliographic coupling by organization

3.4 Detailed Group 3 Search terms for bibliographic coupling network analysis

Search Term: Planetary Boundaries 2009-2017

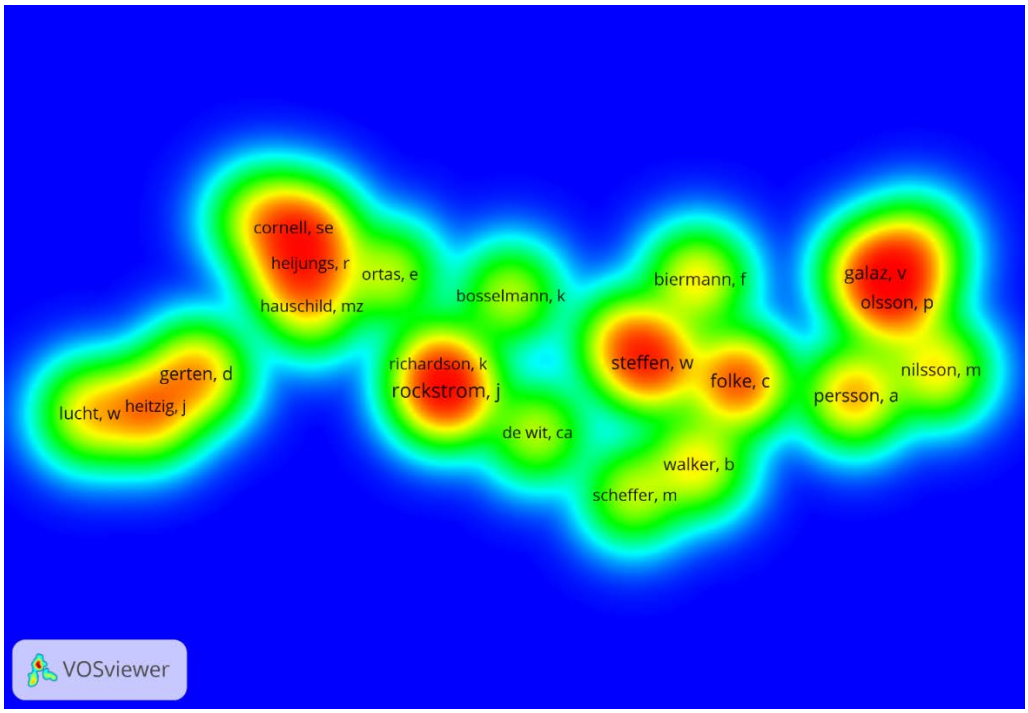

Fig. 127 Planetary Boundaries bibliographic coupling by author

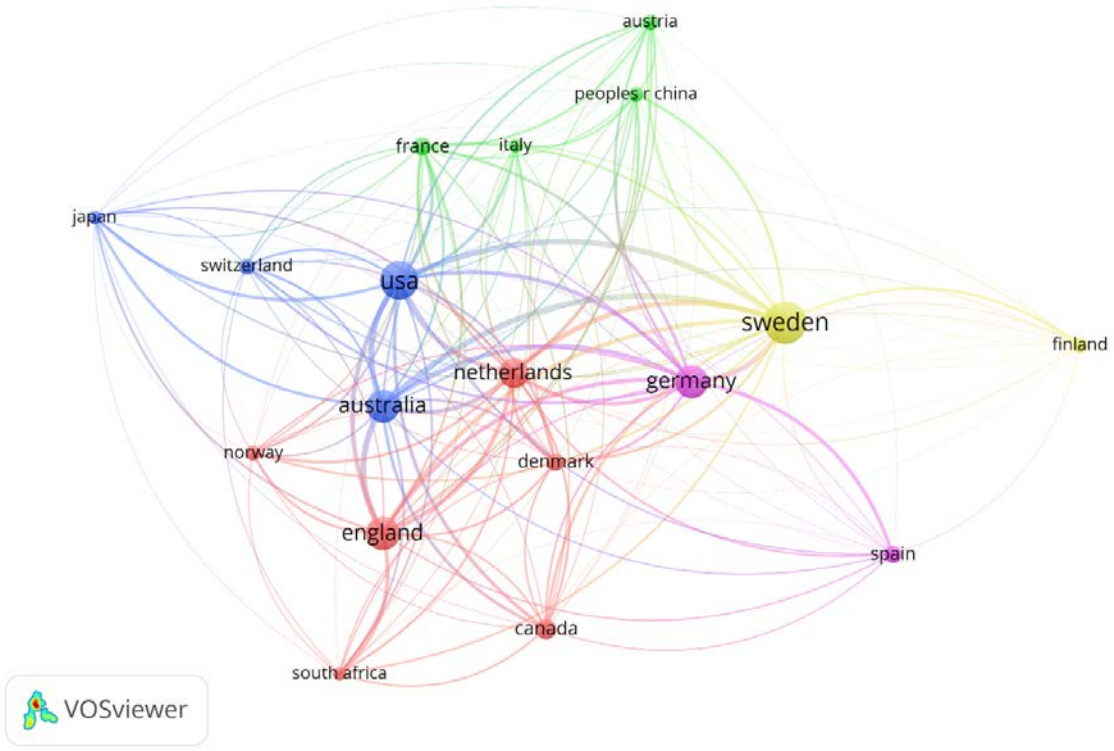

Fig. 128 Planetary Boundaries bibliographic coupling by country

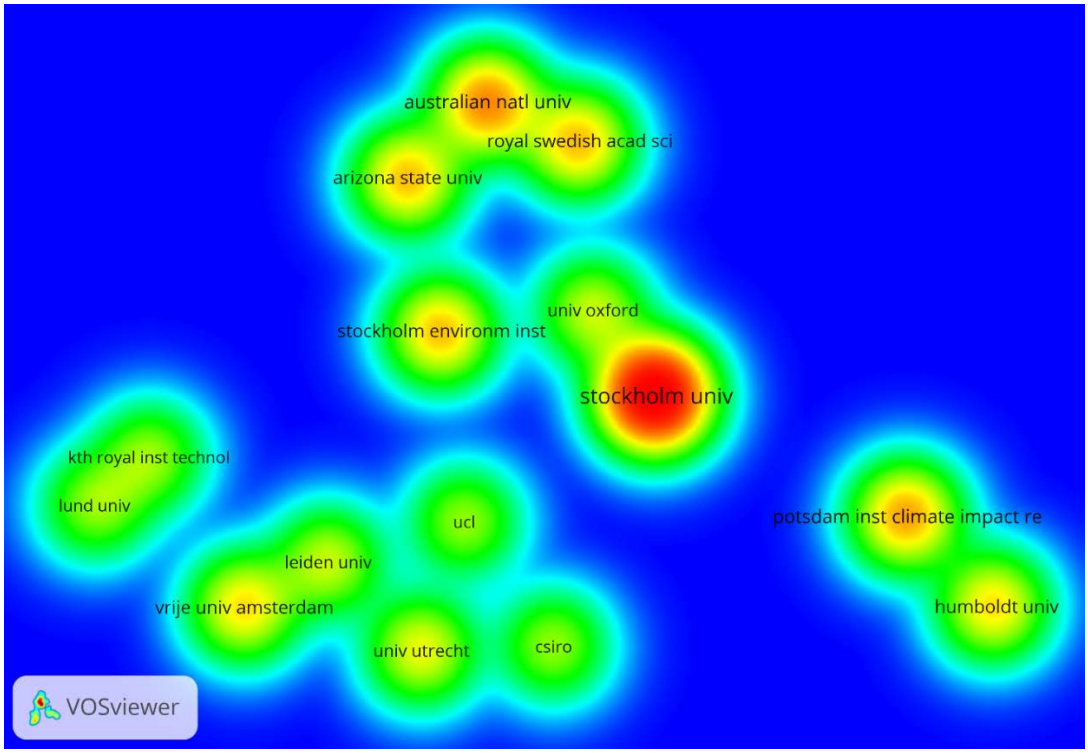

Fig. 129 Planetary Boundaries bibliographic coupling by organization

Search Term: Natural Capital and Ecoservices 1990-2017

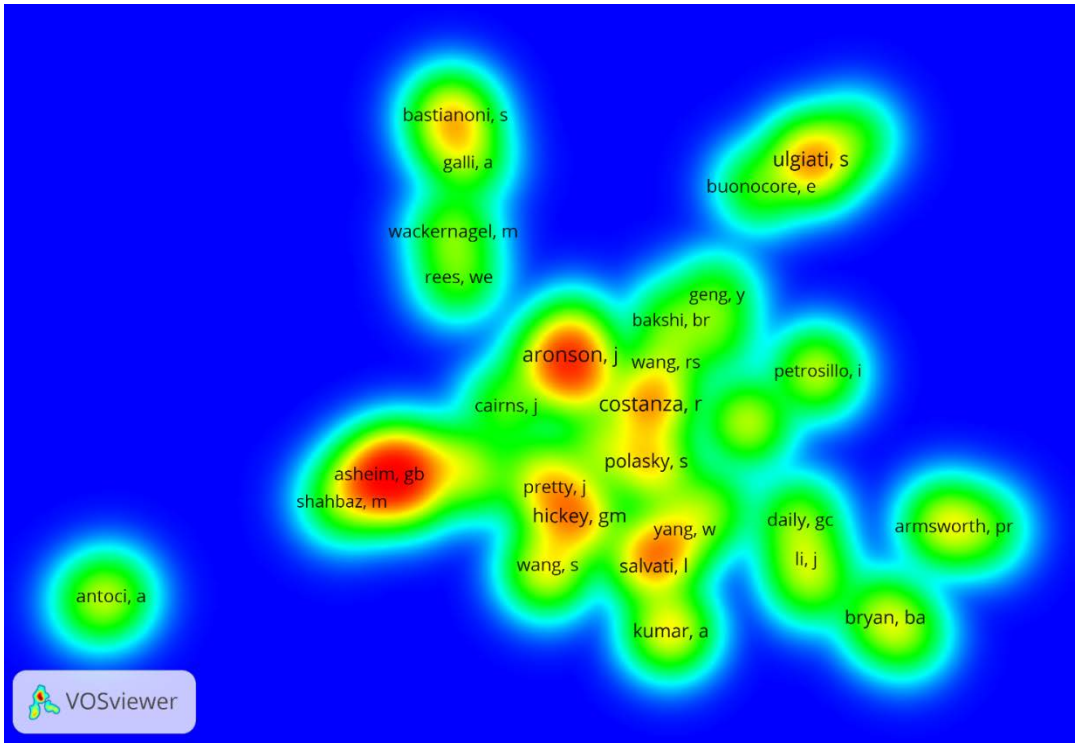

Fig. 130 Natural Capital and Ecoservices bibliographic coupling by author

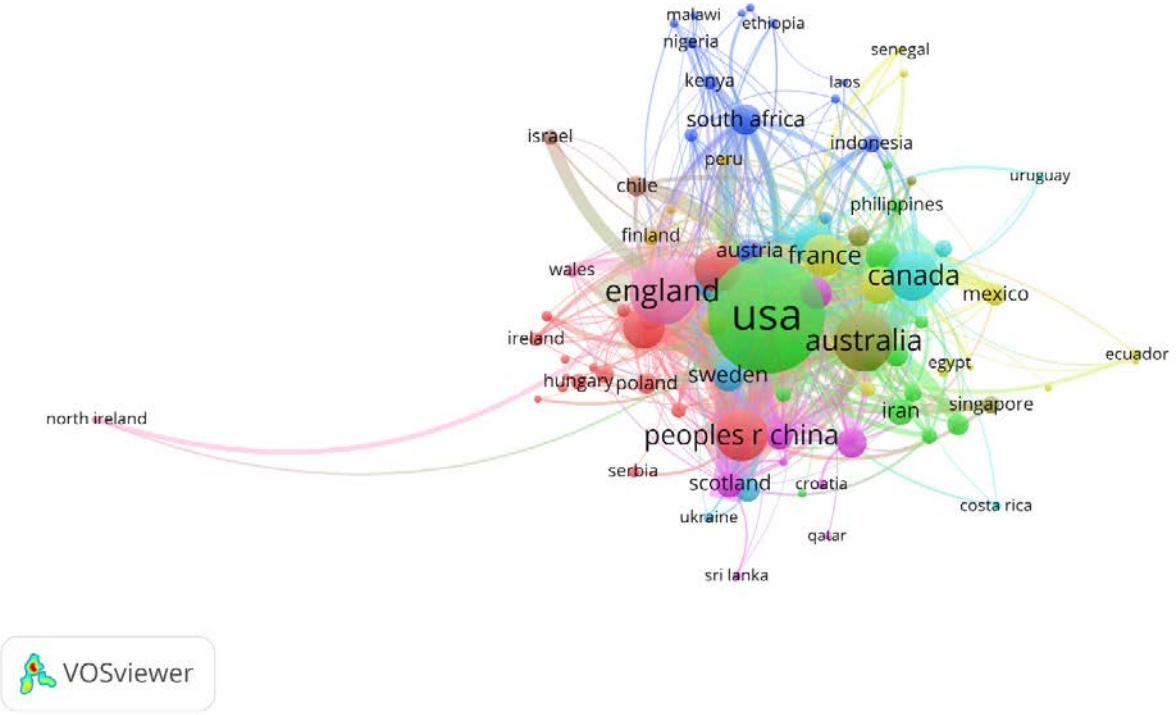

Fig. 131 Natural Capital and Ecoservices bibliographic coupling by country

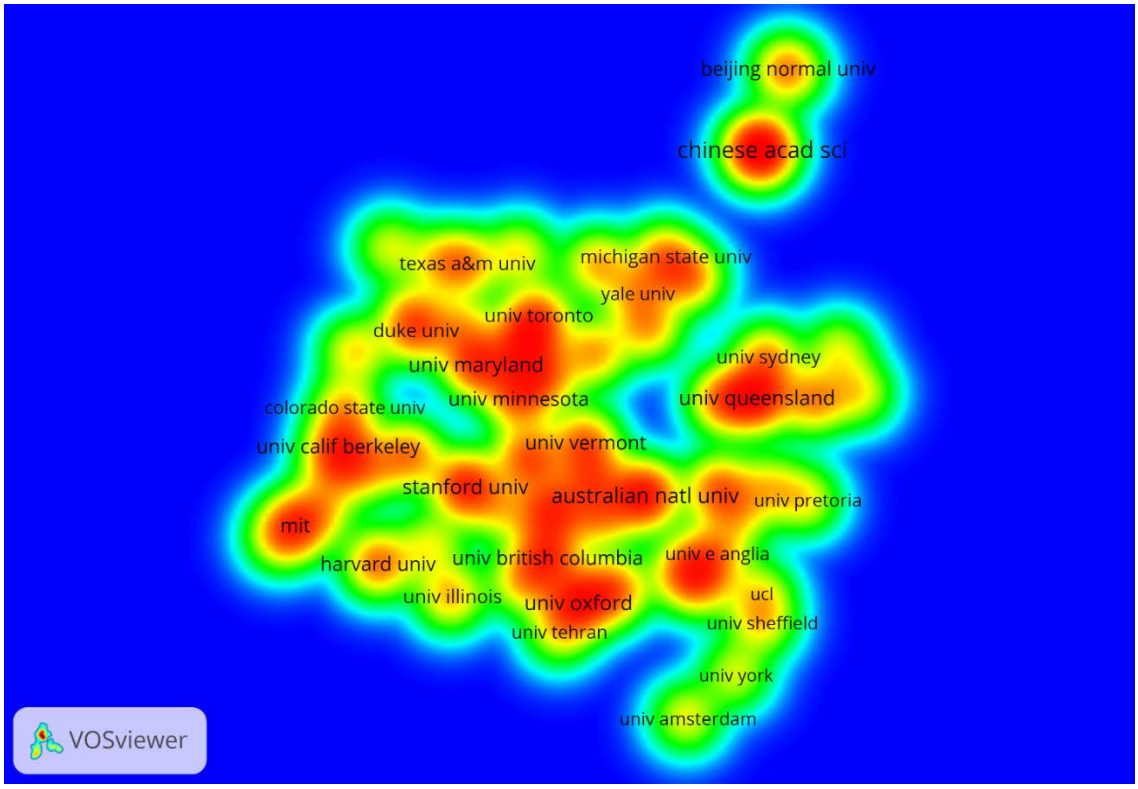

Fig. 132 Natural Capital and Ecoservices bibliographic coupling by organization

Search Term: Circular Economy 1990-2017

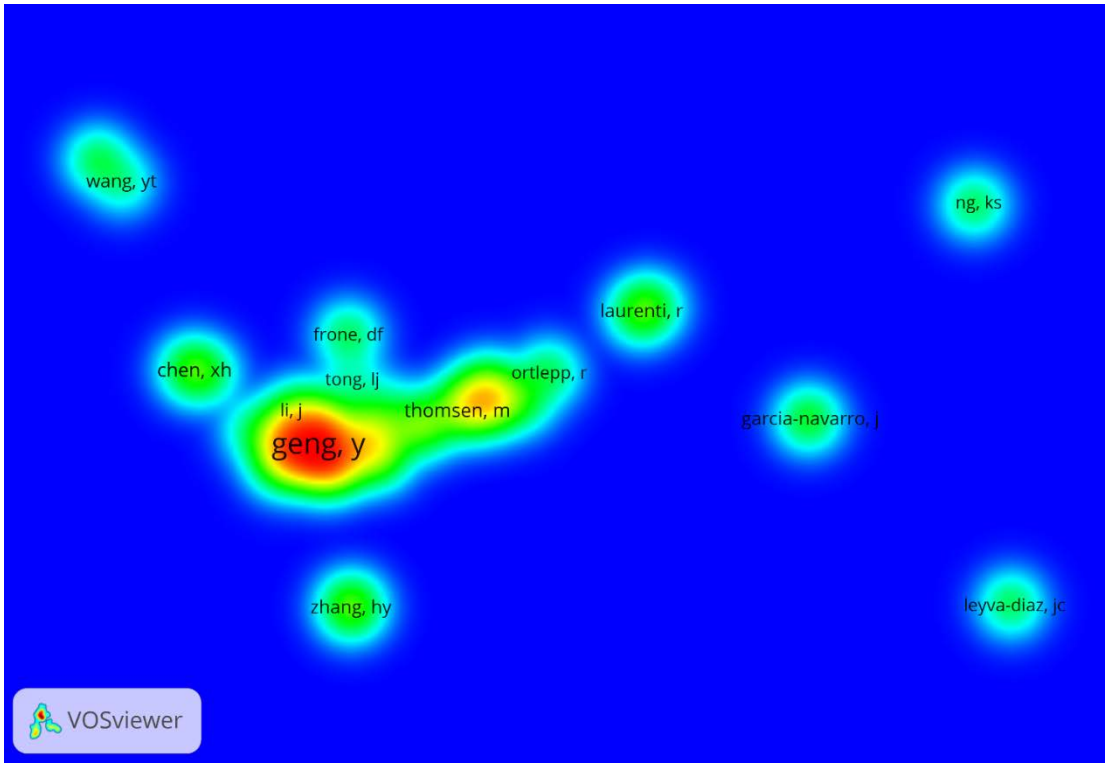

Fig. 133 Circular economy bibliographic coupling by author

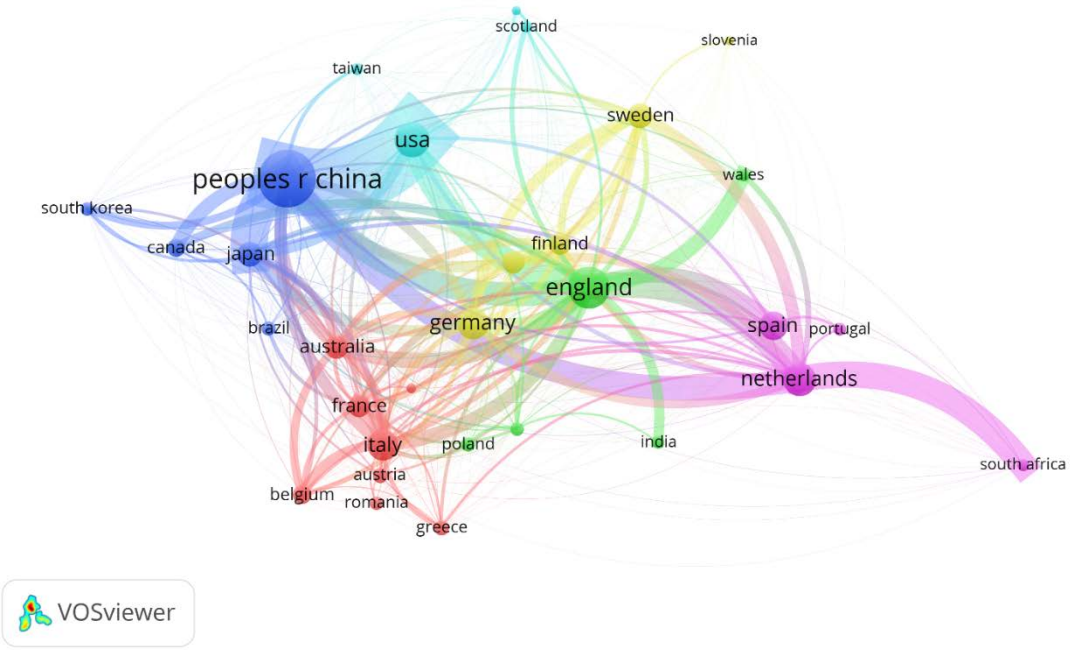

Fig. 134 Circular economy bibliographic coupling by country

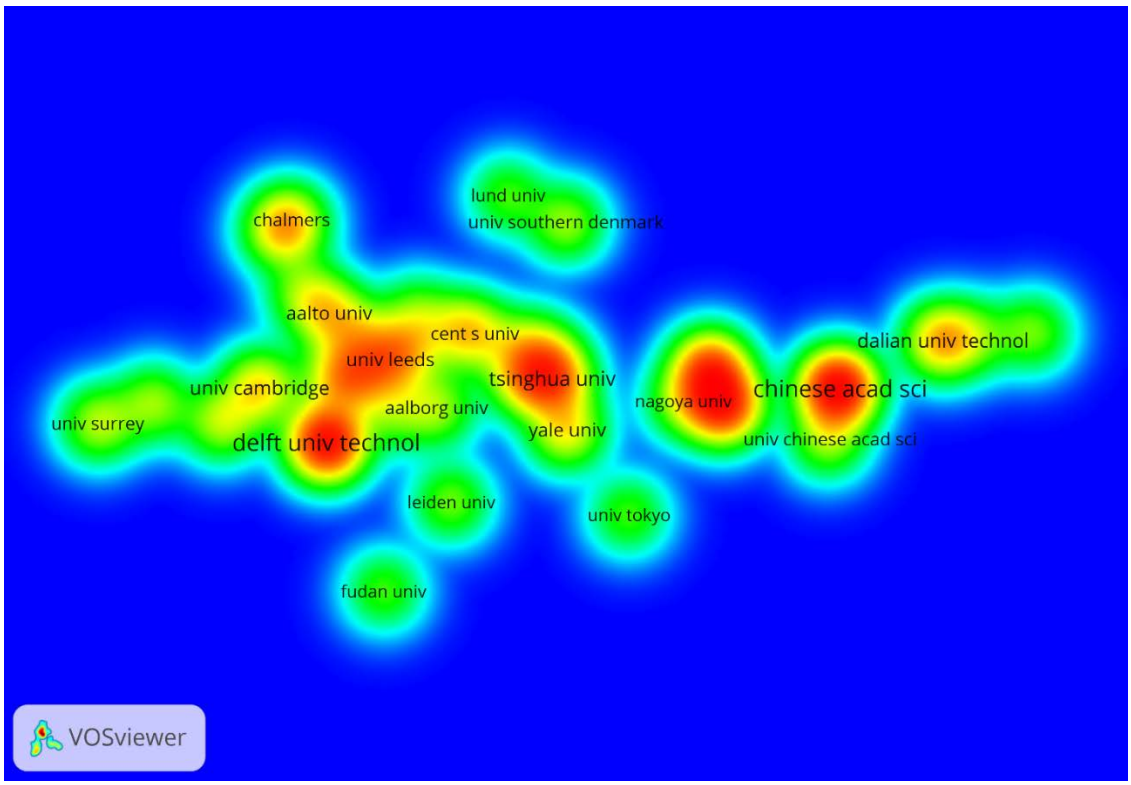

Fig. 135 Circular economy bibliographic coupling by organization

Search Term: Social OR Urban Metabolism 1990-2017

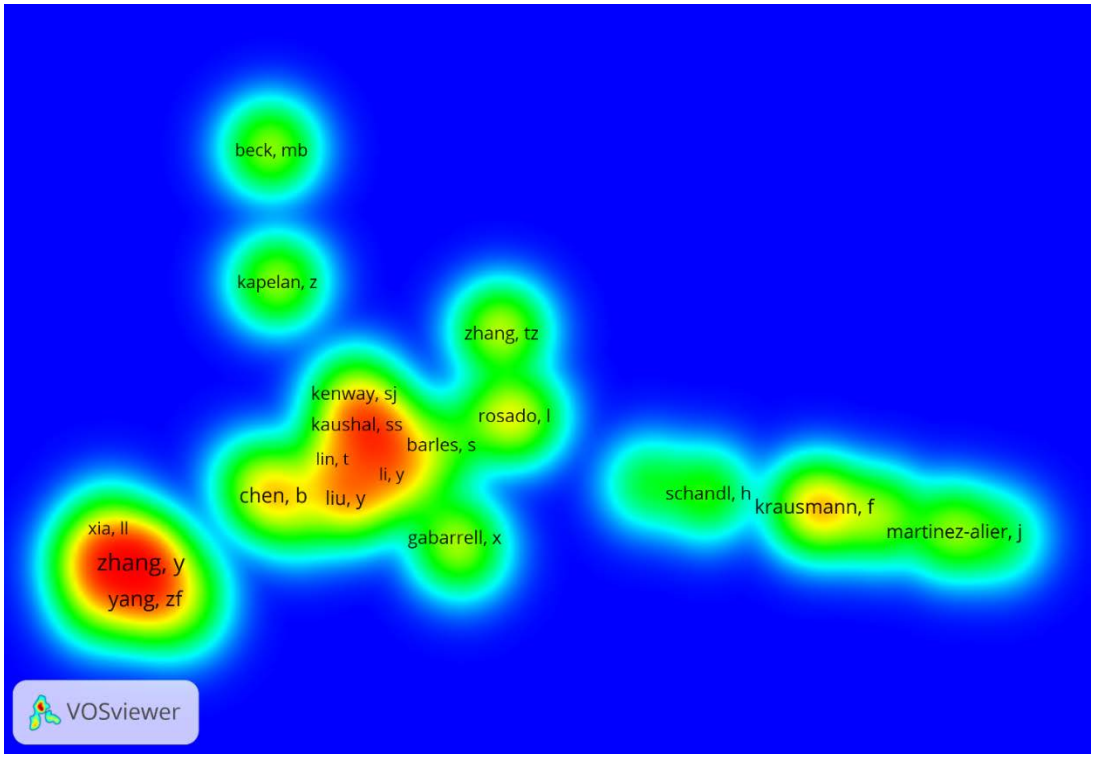

Fig. 136 Social OR Urban Metabolism bibliographic coupling by author

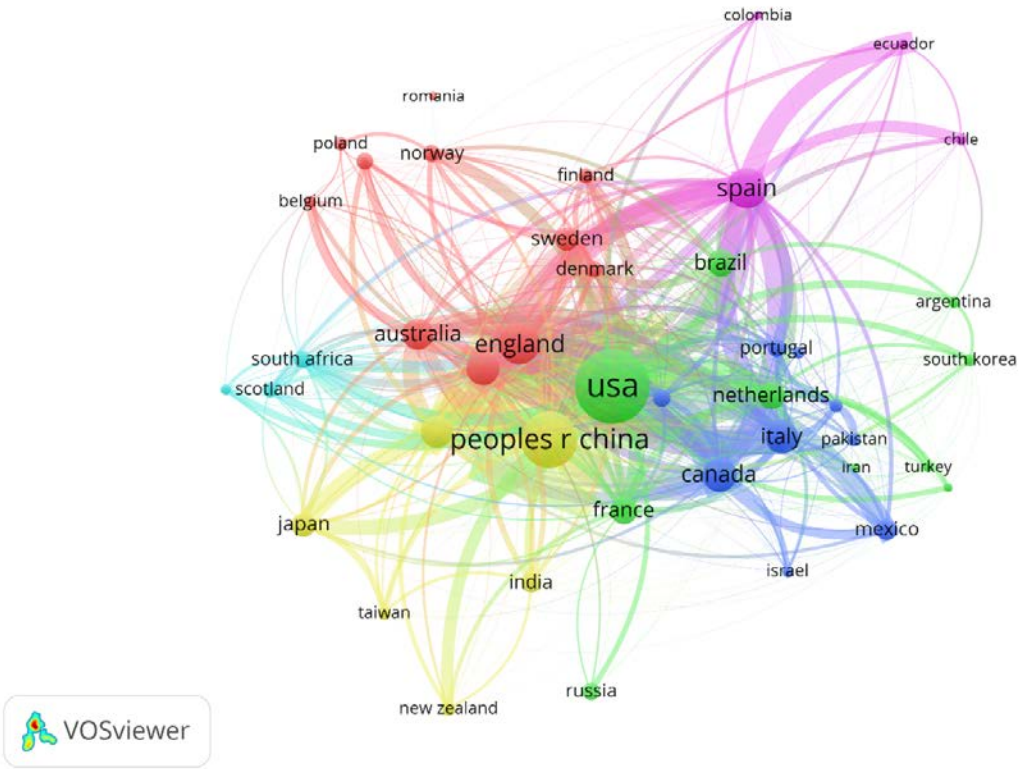

Fig. 137 Social OR Urban Metabolism bibliographic coupling by country

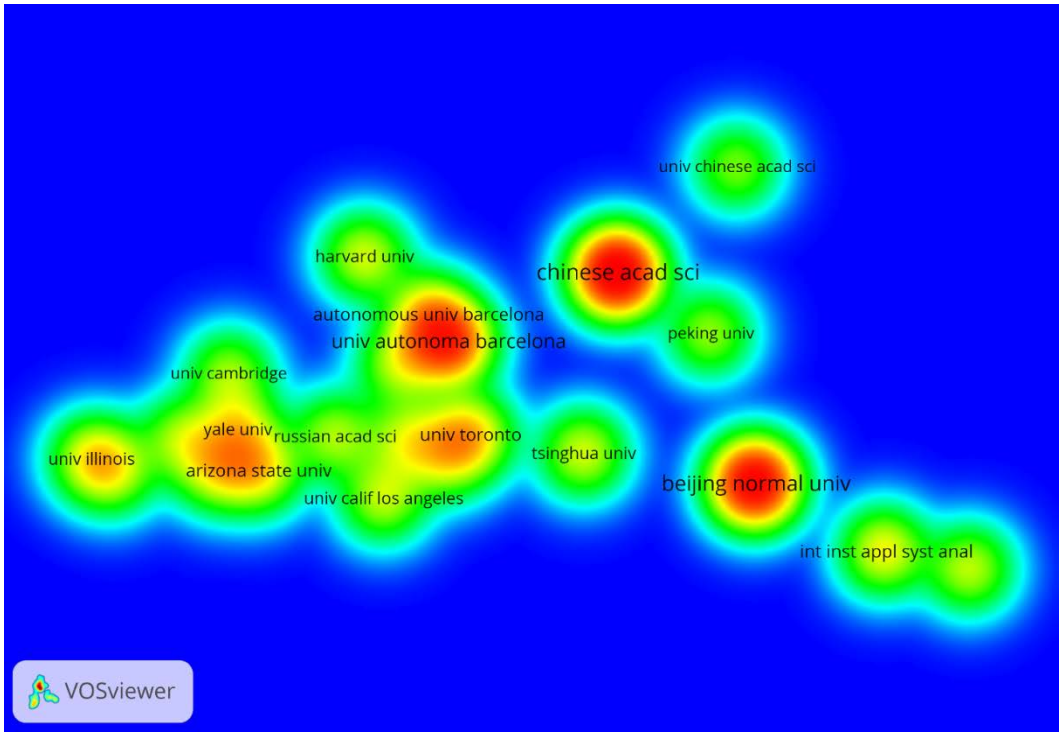

Fig. 138 Social OR Urban Metabolism bibliographic coupling by organization

Search Term: Inclusive Economy OR Inclusive Wealth OR Inclusive Growth 1990-2017

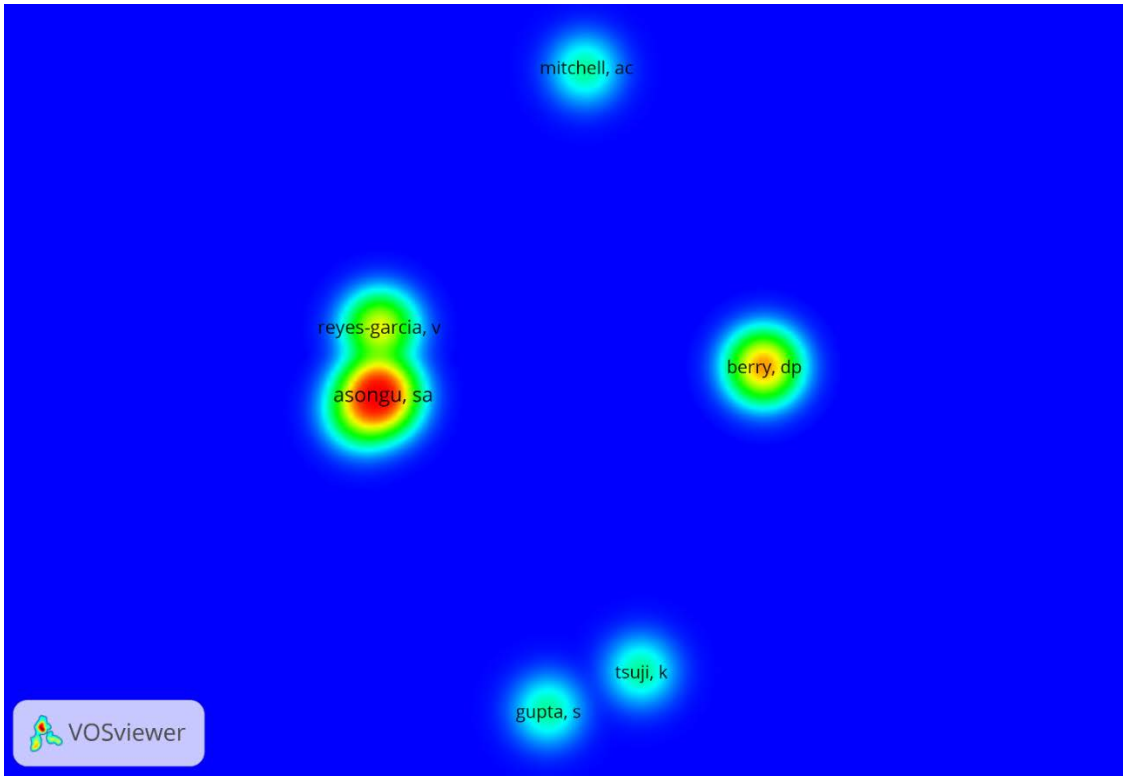

Fig. 139 Inclusive Economy, Inclusive Wealth, Inclusive Growth bibliographic coupling by autho

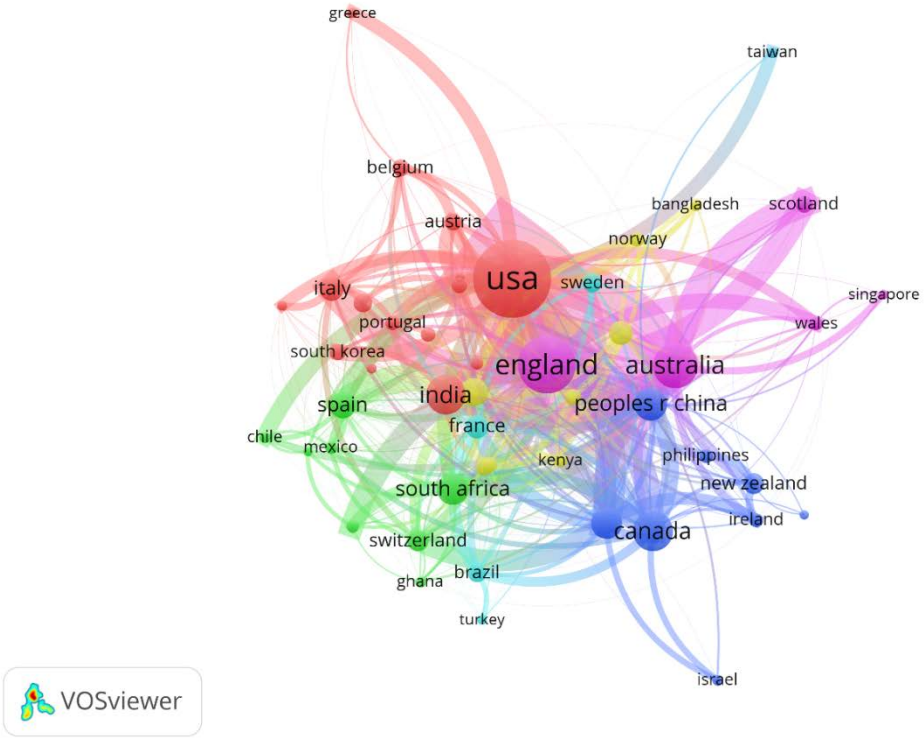

Fig. 140 Inclusive Economy, Inclusive Wealth, Inclusive Growth bibliographic coupling by country

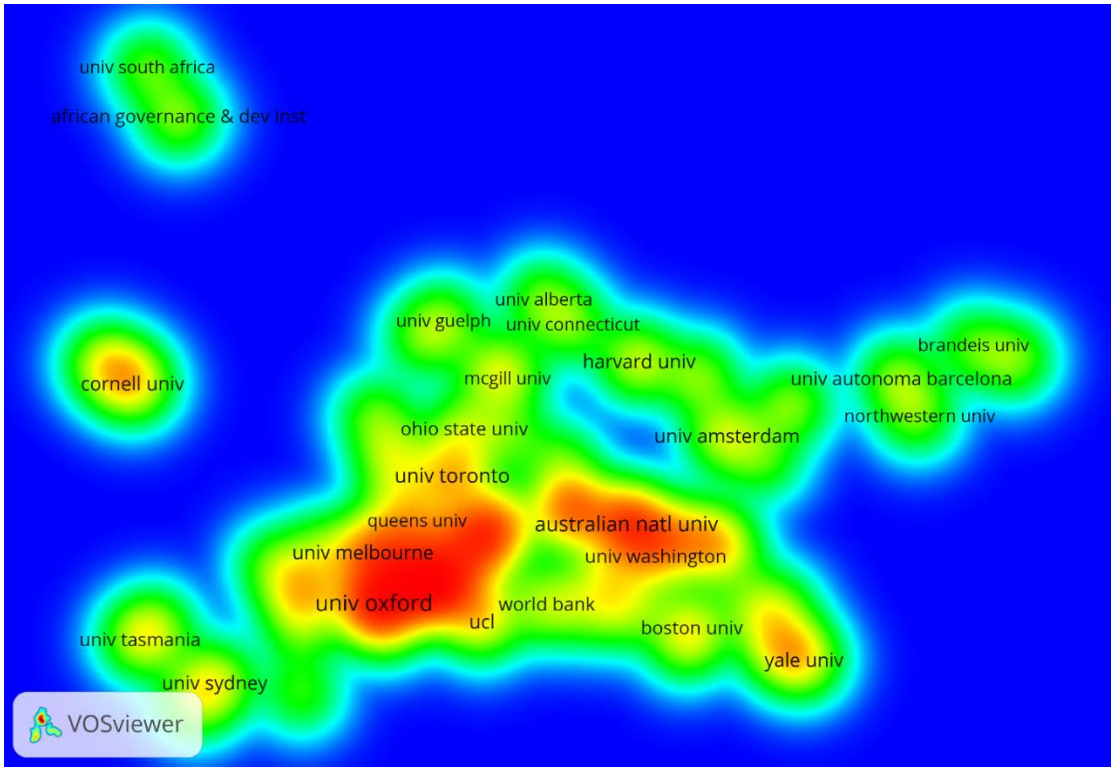

Fig. 141 Inclusive Economy, Inclusive Wealth, Inclusive Growth bibliographic coupling by organization

Search Term: Degrowth 1990-2017

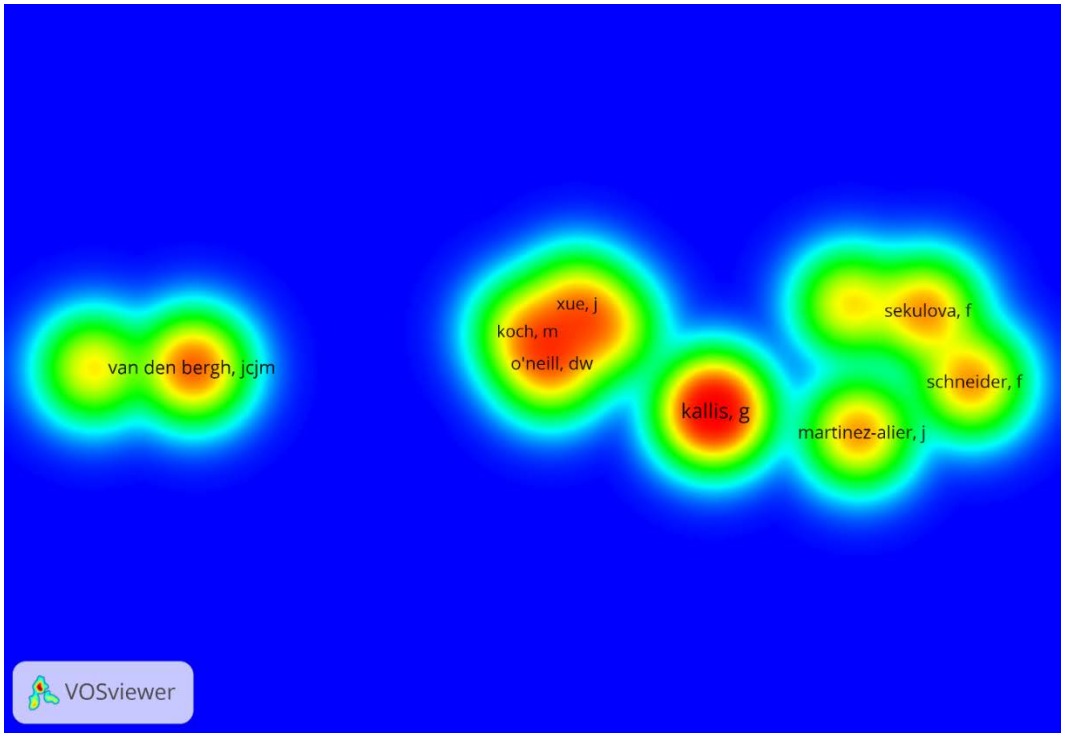

Fig. 142 Degrowth bibliographic coupling by author

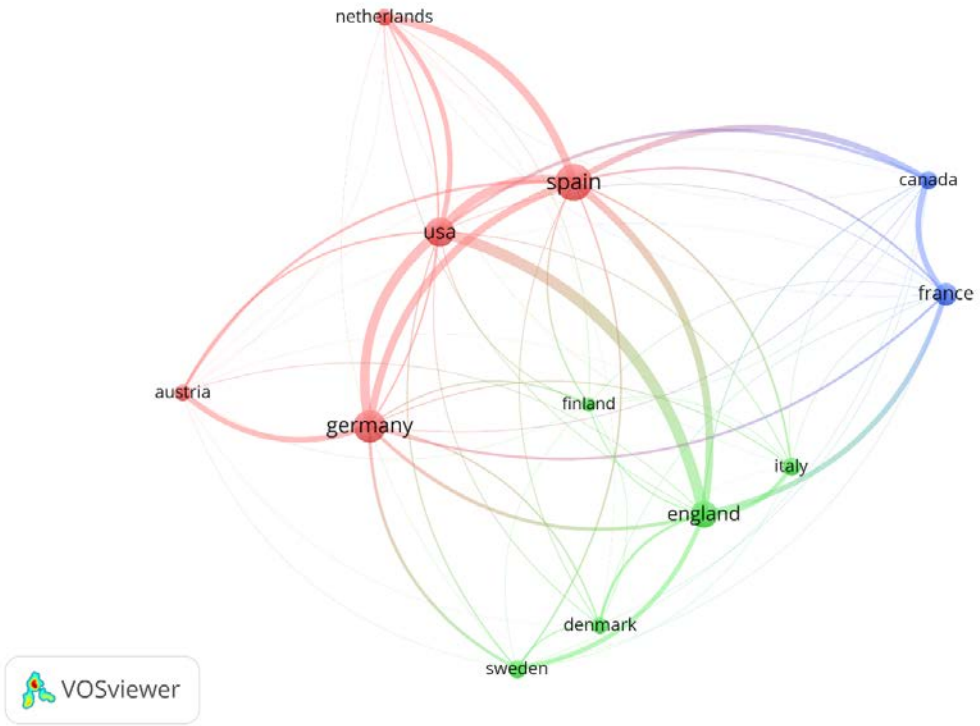

Fig. 143 Degrowth bibliographic coupling by country

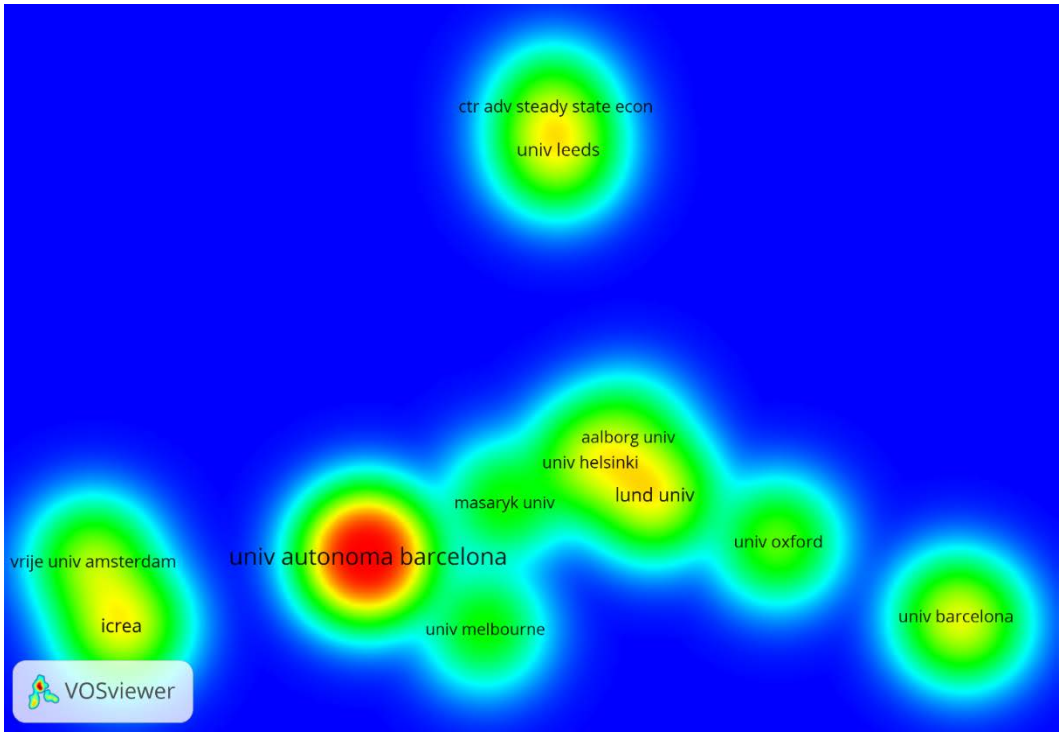

Fig. 144 Degrowth bibliographic coupling by organization

Search Term: Adaptive Governance 1990-2017

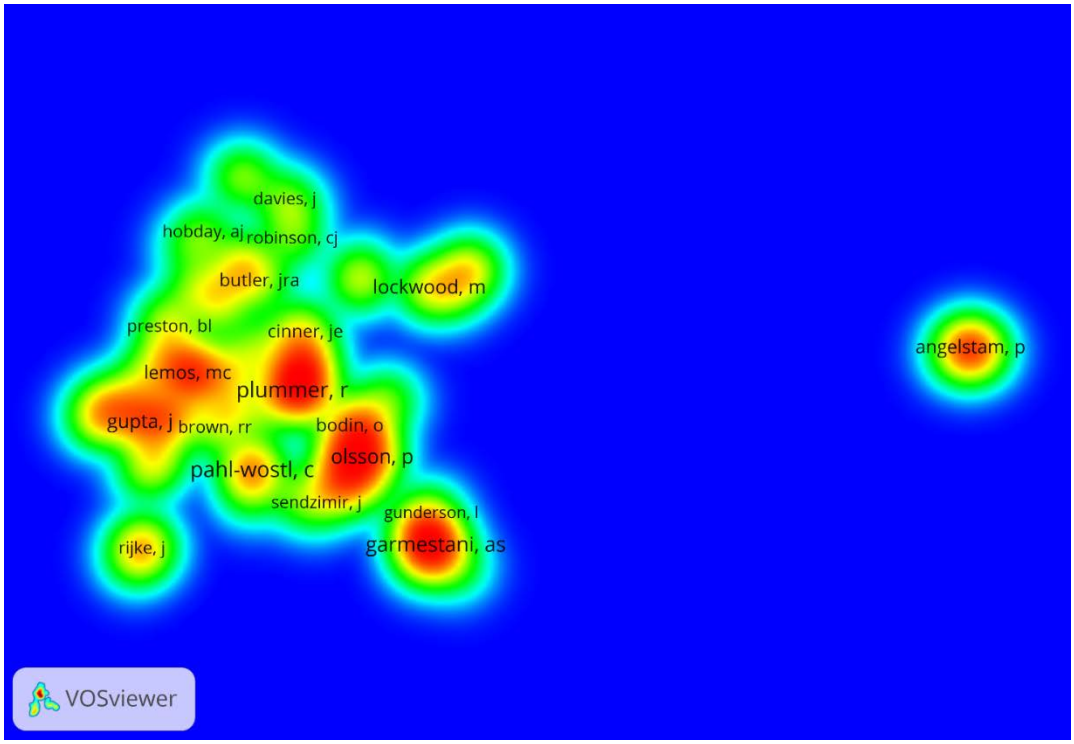

Fig. 145 Adaptive Governance bibliographic coupling by author

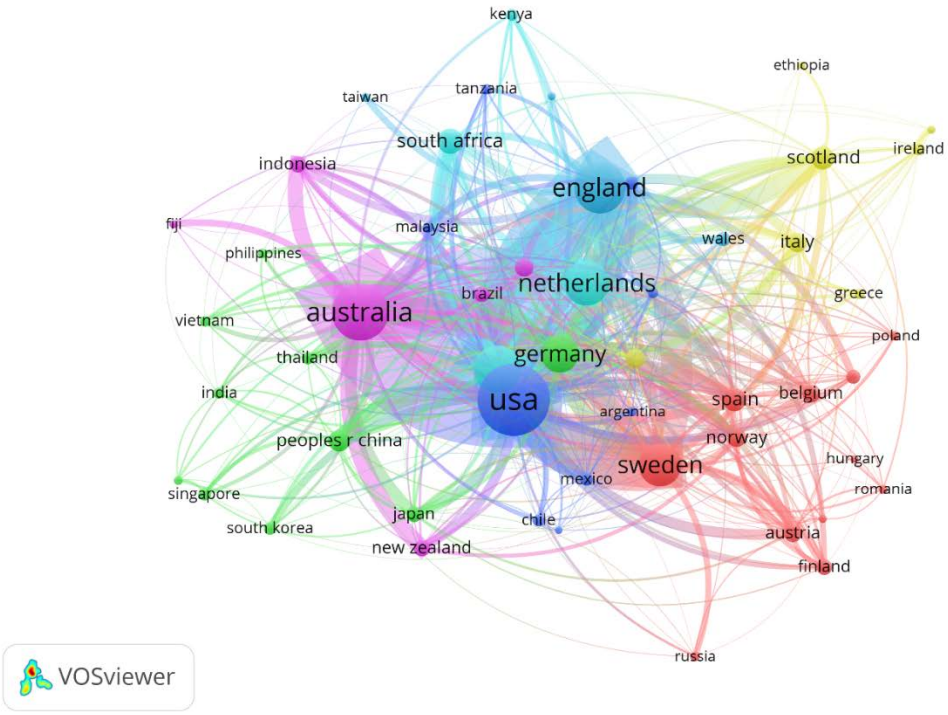

Fig. 146 Adaptive Governance bibliographic coupling by country

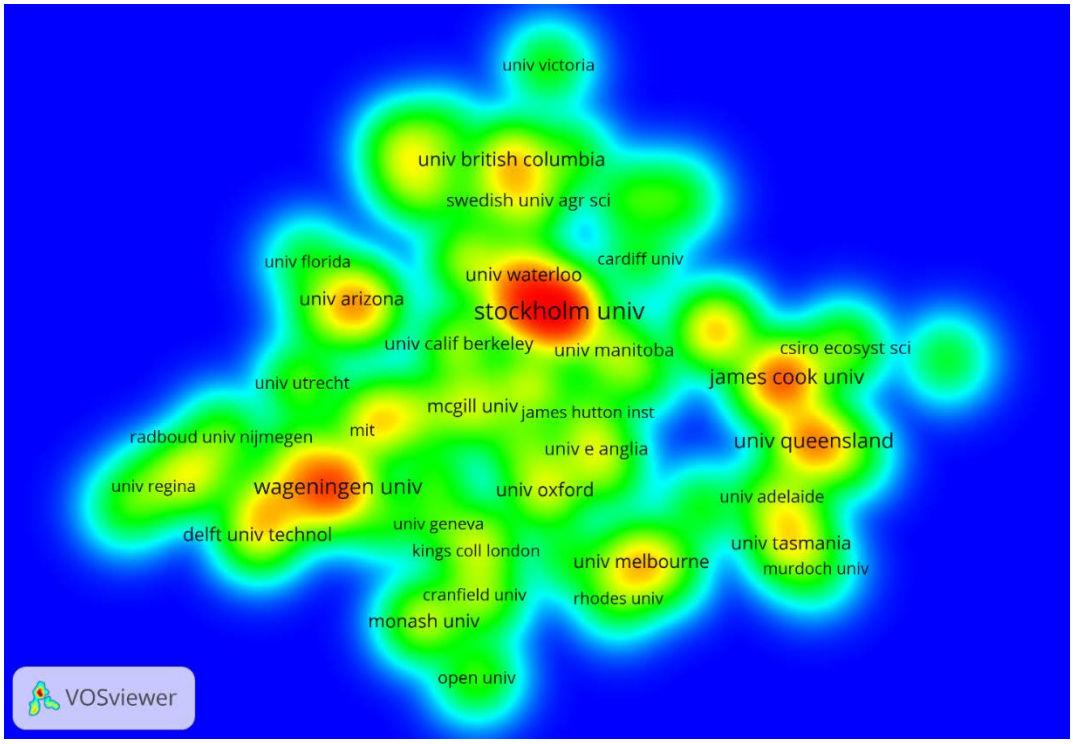

Fig. 147 Adaptive Governance bibliographic coupling by organization

Search Term: Social Cohesion 1990-2017

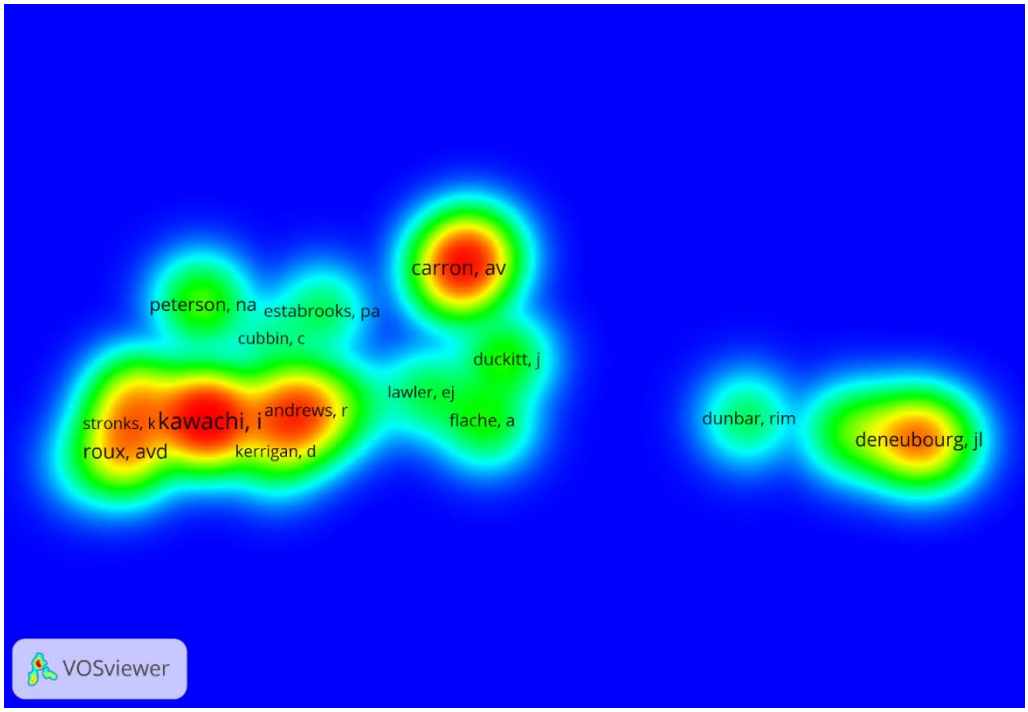

Fig. 148 Social Cohesion bibliographic coupling by author

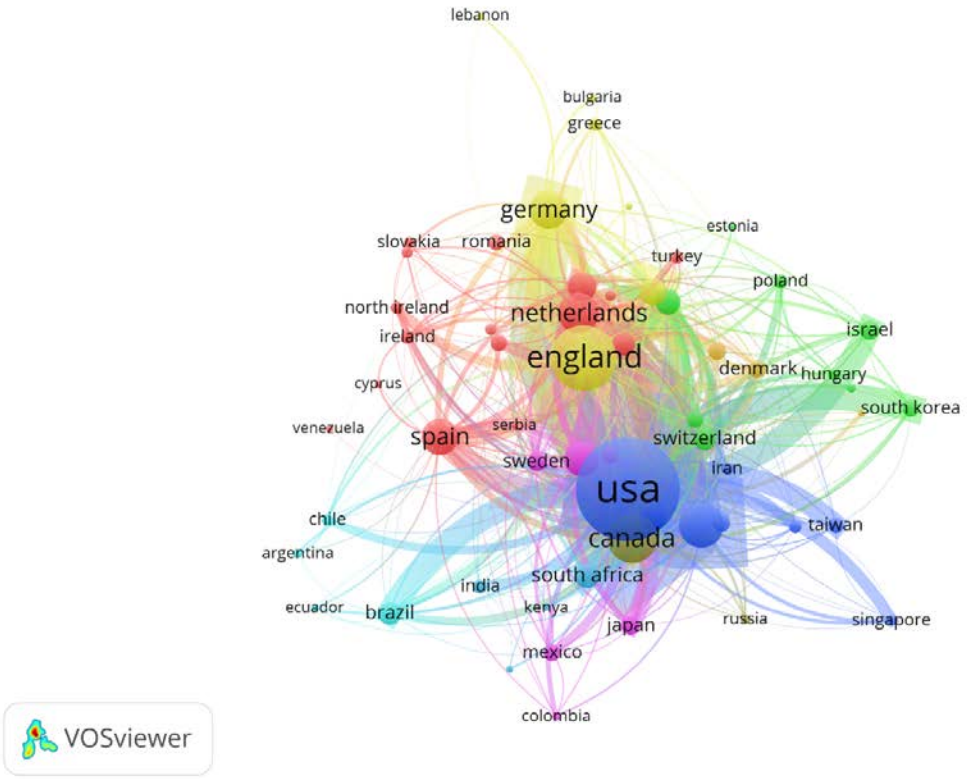

Fig. 149 Social Cohesion bibliographic coupling by country

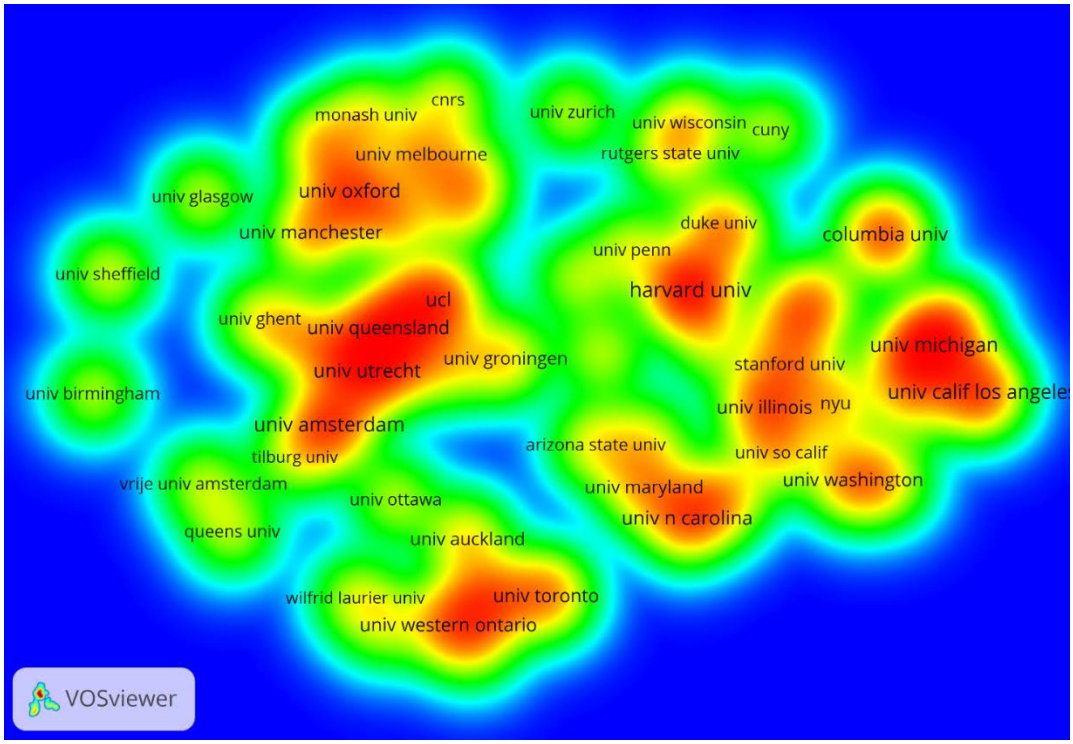

Fig. 150 Social Cohesion bibliographic coupling by organization

Search Term: Social Ecological Systems 1990-2017

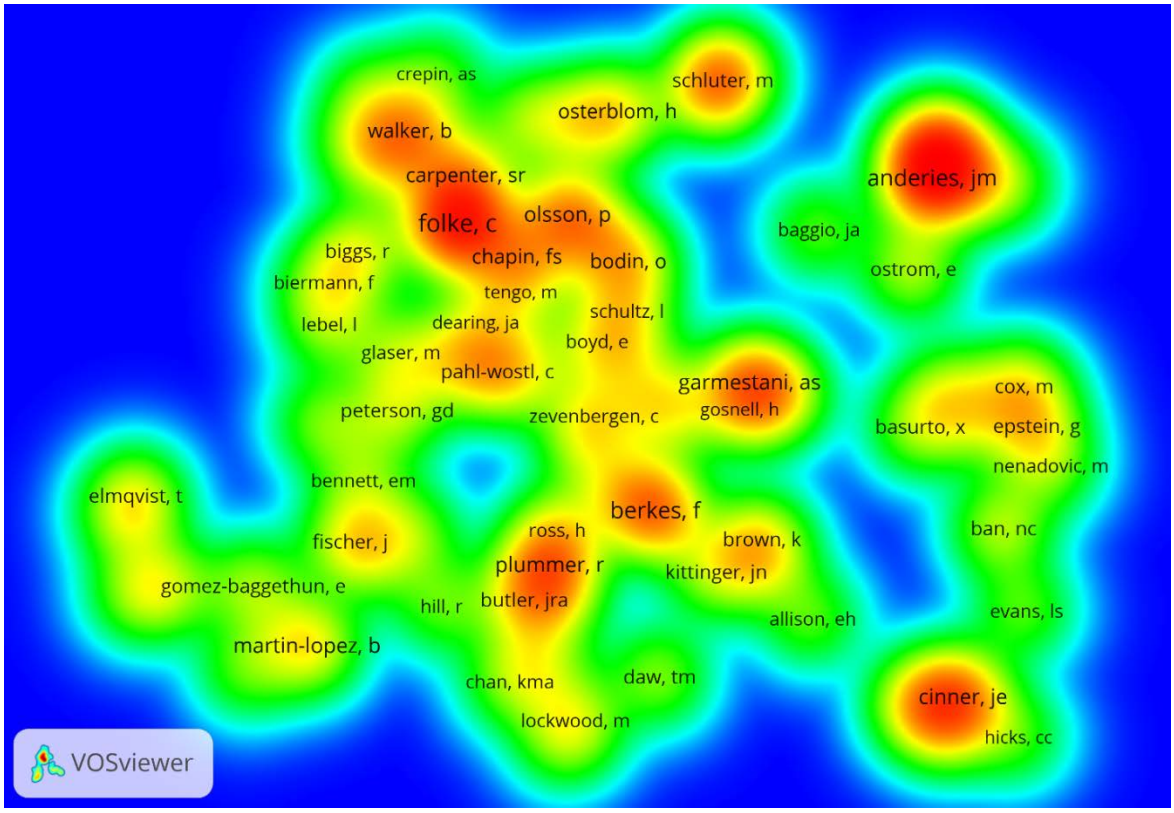

Fig. 151 Social Ecological Systems bibliographic coupling by autho

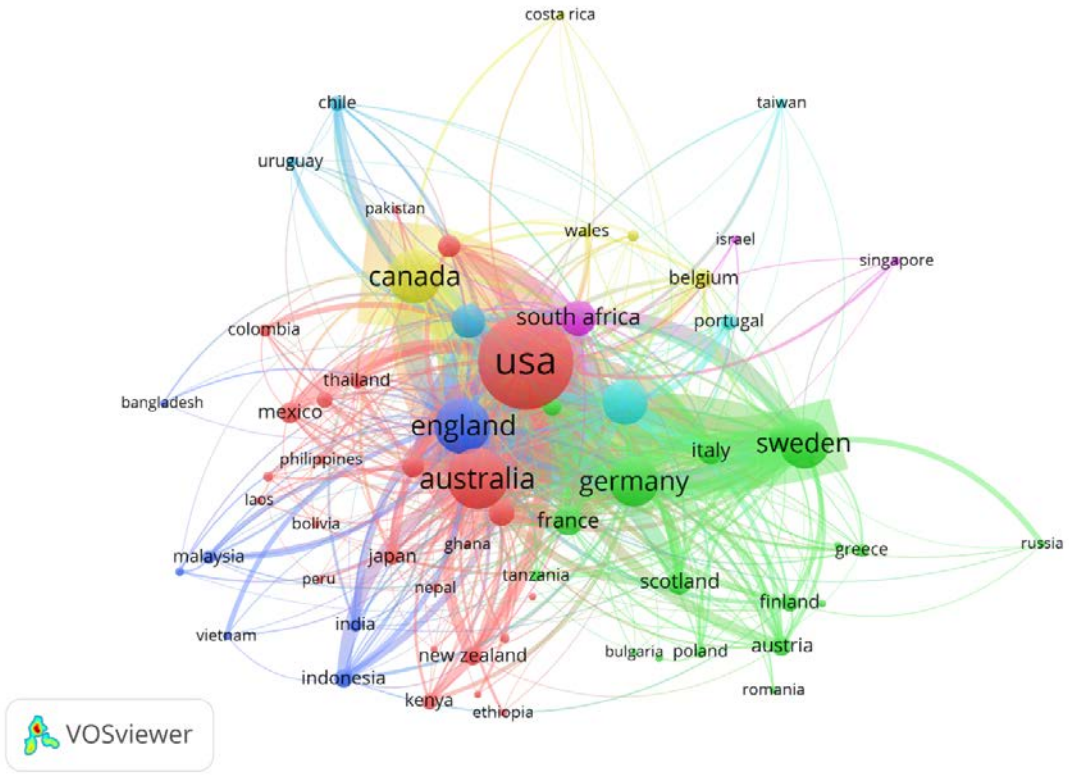

Fig. 152 Social Ecological Systems bibliographic coupling by country

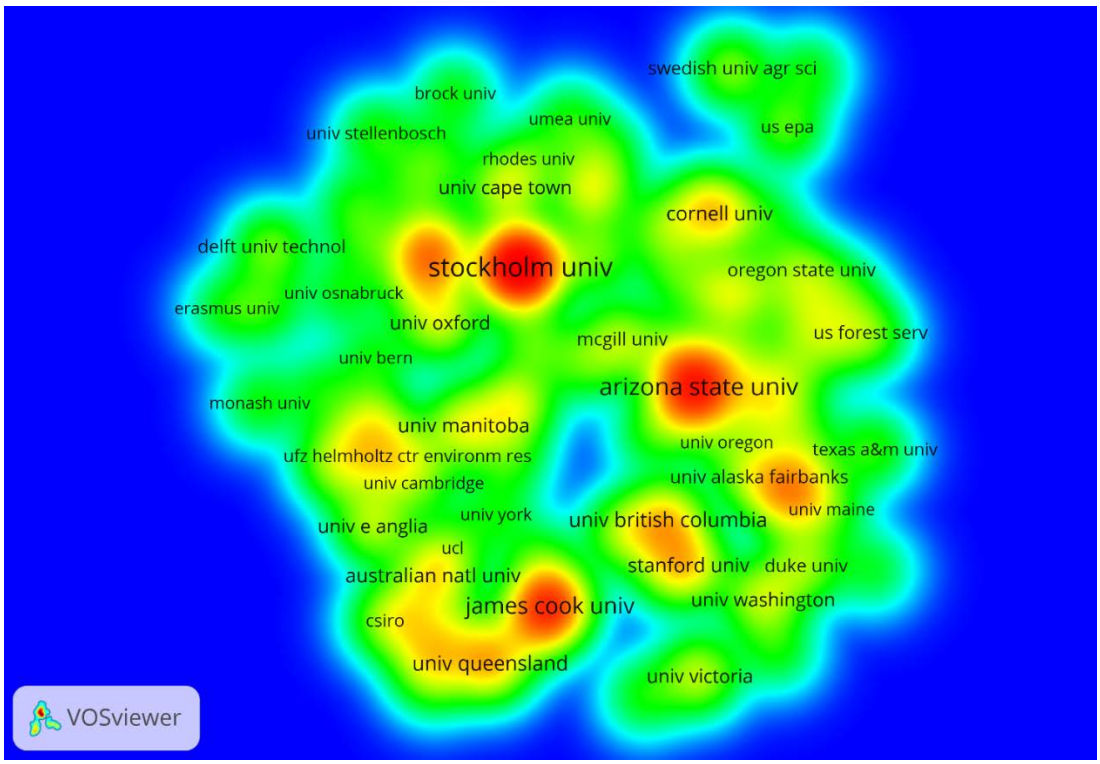

Fig. 153 Social Ecological Systems bibliographic coupling by organization

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